PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION FINAL FEASIBILITY REPORT AND EIS

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE CORPS' PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION FINAL FEASIBILITY REPORT AND EIS REPORT FOR SEPTEMBER 2016



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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

JAN 19 2017

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20515-0001

Dear Mr. Speaker:

Pursuant to section 209 of the River and Harbor Act (RHA) of 1962, Public Law 87-874, the Secretary of the Army supports authorization and initial construction of the Puget Sound Nearshore Ecosystem Restoration Project. The Secretary of the Army supports the continuation of feasibility level studies as authorized under section 209 of RHA 1962 for Dugalla Bay; Everett Marshland; Telegraph Slough; Chambers Bay; Big Beef Creek Estuary; Tahuya River Estuary; Lilliwaup River Estuary; Big Quilcene River; and, Snohomish River Estuary. The proposal is described in the report of the Chief of Engineers, dated September 16, 2016, which includes other pertinent documents. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds. The Water Resources Development Act of 2016 (Public Law 114-322) authorized the recommended project in section 1401(4).

The project study was conducted to analyze and formulate ecosystem restoration which includes facilitating restoration of river deltas, beaches, open coastal inlets, and barrier embayments within the nearshore habitat of Puget Sound, Washington. The recommended plan is the National Ecosystem Restoration (NER) plan. The recommended plan includes initial construction at three locations, Duckabush River Estuary, Nooksack River Delta and North Fork Skagit River Delta and continuing feasibility level study at nine additional locations. In addition, the project study identified eight projects that could be implemented through the Continuing Authorities Program, four projects that could be implemented under section 544 of the Water Resources and Development Act of 2000, and 12 projects that other Federal and non-Federal agencies are implementing. The recommended plan includes:

Duckabush River Estuary: Reconnection of the floodplain and intertidal wetlands, improving tidal exchange, sediment transport, and estuary development for 38 acres of the Duckabush River delta and reconnecting 20 river miles of nearly pristine upstream habitat to support rearing habitat for Hood Canal summer chum salmon, listed as threatened under the Endangered Species Act (ESA) of 1973, as amended. Restoration features include:

- Removal of U.S. Highway 101 causeway and bridges across the estuary to remove barriers to tidal exchange and sediment transport, reconnecting floodplains and intertidal wetlands;

- Construction of an elevated roadway on a 2,100-foot long bridge further upstream from the existing highway to maintain the current transportation access without impairing estuarine restoration;
- Removal of berms along the river to reconnect floodplain and intertidal wetlands; and,
- Excavation of channels at or near their historical configurations to restore dynamic estuarine processes.

Nooksack River Delta: Restoration of riverine and tidal flow and sediment transport and delivery processes to 1,807 acres of tidal freshwater wetlands in the Nooksack River delta thereby restoring habitat critical to some of the largest salmon runs in Puget Sound and restoring 25 percent of the estuary habitat recovery goal in the Puget Sound Action Agenda. Restoration features include:

- Removal of portions of the Nooksack River's west and east bank dikes to restore scarce tidal freshwater wetlands; construction of a levee along the west bank of the Nooksack River, generally aligned with the existing Ferndale Road alignment, to maintain existing levels of flood risk management;
- Relocation of a flood-prone portion of the community of Marietta to restore a small portion of the floodplain, avoid flooding impacts from the east bank levee removal, and avoid additional project costs associated with providing flood risk management features to this relatively small area;
- Installation of large woody debris structures to promote hydraulic stability and improve habitat complexity;
- Installation of a new water control structure at the confluence of the Lummi and Nooksack Rivers intended to facilitate transfer of freshwater and sediment to the Lummi River;
- Grading of the Lummi River channel to reconnect it to Nooksack River flows; removal of approximately 12,000 linear feet of berm on the north bank of the Lummi River in the vicinity of North Red River Road, west of Haxton Way, to restore riverine and tidal flow, sediment transport and delivery processes;
- Construction of a new levee along the north bank of the Lummi River to maintain existing levels of flood risk management; removal and relocation of portions of several existing roadways to restore riverine and tidal flow, sediment transport and delivery processes; and,
- Construction of new bridges or installation of culverts on both the Nooksack and Lummi Rivers to maintain existing transportation access without impairing estuarine restoration.

North Fork Skagit River Delta. Restore 256 acres of scarce tidal freshwater marsh including estuarine emergent marsh, scrub-shrub, and forested floodplain, improve connectivity and reduce fragmentation along the river channel, and improve tidal connectivity and provide critical habitat, including habitat for the Puget Sound Chinook Salmon, listed as threatened under ESA. Skagit River is the largest and most productive river in Puget Sound. Restoration features include:

- Lowering approximately 13,000 feet of levee along the south bank to improve connectivity and reduce fragmentation of riverine wetlands and floodplains;

- Constructing a new levee (Rawlins Road) alignment and tying into the coastal dike system to maintain existing levels of flood risk management to surrounding land and infrastructure, including 208 structures on Fir Island;
- Lowering approximately 3,140 feet of shore armoring on the north bank to improve connectivity to floodplains; breaching portions of the lowered levee and in the areas of armor removal to restore tidal freshwater marsh;
- Excavating channels on both banks of the river to restore tidal connectivity; and
- Replanting native plants on lowered levees in the corridor along the river from 1,700 feet upstream of the Best Road Bridge to the end of the current south bank levee system on Fir Island to improve riparian habitat.

Nine Additional Feasibility Level Studies. The following have been identified as needing additional feasibility level study: Dugualla Bay; Everett Marshland; Telegraph Slough; Chambers Bay; Big Beef Creek Estuary; Tahuya River Estuary; Lilliwaup River Estuary; Big Quilcene River; and Snohomish River Estuary. Implementation of the nine additional sites would be subject to preparation of feasibility level decision documents and a favorable determination by the Secretary that the proposed projects are technically sound, cost effective, and environmentally acceptable.

Based on October 2016 (Fiscal Year 2017) price levels, the estimated project first cost of the initial construction is $461,552,000. The total project first costs includes $77,248,000 for pre-construction engineering and design, $175,935,000 for aquatic ecosystem restoration construction; $31,108,000 for construction management costs; $6,389,000 for cultural resource preservation costs; $1,129,000 for monitoring costs; $5,401,000 for adaptive management costs; and $164,341,000 for lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas costs.

The Washington State Department of Fish and Wildlife is the non-Federal cost-sharing sponsor for all features. The estimated Federal and non-Federal shares of the project first costs for the recommended plan are $300,009,000 and $161,543,000, respectively (which equates to 65 percent Federal and 35 percent non-Federal), as apportioned in accordance with the cost sharing provisions of section 103(c) of WRDA 1986, as amended (33 U.S.C. 2213(c)). Operation, maintenance, repair, replacement, and rehabilitation expenses are estimated to be approximately $863,000 per year and are the responsibility of the non-Federal sponsor.

Based on the FY 2017 price levels, a 2.875 percent discount rate, and a 50-year period of economic analysis, the total equivalent average annual costs of the project are estimated to be $21,089,000. The recommended plan is estimated to restore 716.5 average annual habitat units of non-monetary ecosystem restoration benefits. The three initial construction locations of the recommended plan will remove nearly 28,860 linear feet of shoreline stressors (including tidal barriers, nearshore fill, and shoreline armoring); thereby restoring processes that would restore 2,101 acres of tidally influenced wetlands in river deltas. These actions would restore wetlands that have either been lost due to fill or blocked by tidal barriers and lack sediment transport and delivery to beaches and embayments. Restored sediment transport and delivery will support biologically diverse habitats in the affected estuaries. This includes maintenance of eelgrass beds and kelp beds immediately downstream. Refuge habitat will be provided for juvenile salmonids along with critical rearing and foraging habitat. Benefits to salmonids would also benefit the southern resident

killer whale (Puget Sound Orca), listed as endangered under ESA, by providing additional forage. Restoration actions would support recovery of three species listed as endangered and 10 species listed as threatened under ESA.

An Environmental Impact Statement and Record of Decision were prepared in accordance with the National Environmental Policy Act. The recommended plan has been identified as the environmentally preferred alternative. Adverse environmental impacts have been avoided and minimized where practicable. No compensatory mitigation is required.

In accordance with the ESA, U.S. Fish and Wildlife Service and National Marine Fisheries Service confirmed that the recommended plan is consistent with the 2008 Fish Passage and Habitat Restoration Programmatic Biological Opinion (BiOp) and that the project will not jeopardize the existence of Federally listed species or modify designated critical habitat. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species.

The Independent External Peer Review was completed by Battelle Memorial Institute. The review comments resulted in expanded narratives throughout the report to support the decision-making process and justify the recommended plan. All comments from the above referenced reviews have been addressed and incorporated into the final documents.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress and concludes that the report recommendation is consistent with the policy and programs of the President. A copy of OMB's letter, dated January 18, 2017, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also sending an identical letter to the President of the Senate.

Very truly yours,

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

Enclosures

5 Enclosures

1. Report of the Chief of Engineers, September 16, 2016
2. OMB Clearance Letter, January 18, 2017
3. Record of Decision, January 19, 2017
4. Summary of State and Agency Review
5. Puget Sound Nearshore Ecosystem Restoration, Final Integrated Feasibility Report and Environmental Impact Statement, July 2016

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, DC 20310-2600

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DAEN

SUBJECT: Puget Sound Nearshore Ecosystem Restoration, Washington

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my interim report on Puget Sound Nearshore Ecosystem Restoration, Washington. It is accompanied by the reports of the Seattle District Engineer and the Northwestern Division Engineer. These reports are an interim response to the authority of Section 209 of the River and Harbor Act of 1962, Public Law 87-874. This authority directed the Secretary to "cause surveys for flood control and allied purposes...in Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources." Preconstruction engineering and design and additional studies, if funded, will continue under the authority cited above.

2. The Puget Sound is designated as an estuary of national significance under the Environmental Protection Agency's National Estuary Program. The Puget Sound is also subject to a Federal Caucus consisting of 15 Federal Agencies focused on restoring the health of the ecosystem within the Puget Sound. Also, the Puget Sound is a part of the Salish Sea, a transboundary ecosystem between the United States and Canada. Both countries share a unique responsibility to address environmental challenges and as a result have signed a Joint Statement of Cooperation and have developed an action plan to address the goals of the Joint Statement of Cooperation signed on 19 January 2000. There are currently 13 fish and marine mammal species in Puget Sound that are listed as threatened or endangered species under the Endangered Species Act. Local, State, Tribal, and Federal agencies, along with concerned citizens, nonprofit organizations, ports, and businesses recognize the need to identify nearshore ecosystem problems, evaluate potential solutions, and to restore and protect the critical ecosystem functions of the nearshore zone. The proposed actions from the Puget Sound Nearshore Ecosystem Restoration Study are integral to this comprehensive effort. Implementing the restoration actions proposed by the study is identified in the Federal and State Puget Sound Action Agenda as a near-term priority for Puget Sound recovery.

3. A strategy for the restoration of the Puget Sound Nearshore was developed through a multi-agency collaborative effort. This strategy includes 36 sites that could facilitate restoration of river deltas, beaches, open coastal inlets, and barrier embayments within the Puget Sound Nearshore. Of the 36 sites, 12 sites are being evaluated for solutions that will be implemented by other agencies; four sites are being evaluated for solutions that could be implemented under Section 544 of the Water Resources Development Act (WRDA) 2000; eight sites are being evaluated for solutions that can be implemented under existing general continuing authorities such as Section 206 of WRDA 1996, as

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amended, and Section 1135 of WRDA 1986, as amended; and 12 sites are being evaluated for solutions that will require specific authorization.

4. The reporting officers recommend construction authorization at this time of a National Ecosystem Restoration (NER) Plan that will restore aquatic ecosystem structure and function to three sites in the Puget Sound Nearshore - the Duckabush River Estuary, the Nooksack River Delta, and the North Fork Skagit River Delta. Benefits from the NER plan would derive from removing nearly 28,860 linear feet of shoreline stressors (including tidal barriers, nearshore fill, and shoreline armoring); thereby restoring processes that would restore 2,101 acres of tidally influenced wetlands in river deltas. These actions would restore wetlands that have either been lost due to fill or blocked by tidal barriers and lack sediment transport and delivery to beaches and embayments. Restored sediment transport and delivery will support biologically diverse habitats in the affected estuaries. This includes maintenance of eelgrass beds and kelp beds immediately downstream. Refuge habitat will be provided for juvenile salmonids along with critical rearing and foraging habitat. Benefits to salmonids would also benefit killer whales by providing additional forage. Restoration actions would support recovery of three listed endangered species and 10 threatened species.

5. The three elements of the NER Plan are described below.

a. Duckabush River Estuary. The reporting officers recommend a plan for the Duckabush River Estuary that would reconnect floodplain and intertidal wetlands, improving tidal exchange, sediment transport, and estuary development. Tidal and riverine hydrology would be restored to 38 acres of the Duckabush River delta, allowing for natural habitat forming processes including sediment and detritus exchange, freshwater input, and tidal flushing within the delta. Restoration in the Duckabush River will provide rearing habitat for Hood Canal summer chum salmon by reconnecting 20 river miles of nearly pristine upstream habitat with a now fully functional salt marsh and mudflat estuary. Key restoration elements at this site include the following:

- Removal of the Highway 101 causeway and bridges across the estuary;
- Construction of an elevated roadway on a 2,100-foot-long bridge further upstream from the existing highway; and
- The removal of berms along the river and the excavation of channels at or near their historical configurations.

At March 2016 price levels, the estimated first cost of this element is $90,523,000. The estimated annual cost for operation, maintenance, repair, replacement and rehabilitation of this project element is $122,000 and is a non-federal responsibility.

b. Nooksack River Delta. The reporting officers recommend a plan for the Nooksack River Delta that would modify levees, roads, and other hydrological barriers to restore riverine and tidal flow and sediment transport and delivery processes to the Nooksack River delta, restoring 1,807 acres of tidal freshwater wetlands. Restoration at

the Nooksack River Delta is critical to some of the largest salmon runs in Puget Sound and would provide 25% of the Puget Sound Action Agenda's estuary habitat recovery goal. Removal of stressors will help restore tidal freshwater wetlands and support productive estuarine mixing and tidal freshwater marshes. Tidal marshes provide habitat for birds, and are used by five species of Pacific salmon during critical portions of their life cycle. Key restoration elements at this site include the following:

- Removal of portions of the Nooksack River's west and east bank dikes;
- Construction of a levee along the west bank of the Nooksack River to maintain existing levels of flood risk management. The levee will generally follow the existing Ferndale Road alignment;
- Installation of large woody debris structures to promote hydraulic stability and improve habitat complexity;
- Relocation of a flood-prone portion of the community of Marietta to restore a small portion of the floodplain, avoid flooding impacts from the east bank levee removal, and avoid additional project costs associated with providing flood risk management features to this relatively small area;
- Installation of a new water control structure at the confluence of the Lummi and Nooksack Rivers intended to facilitate transfer of freshwater and sediment to the Lummi River;
- Grading of the Lummi River channel to reconnect it to Nooksack River flows;
- Removal of approximately 12,000 linear feet of berm on the north bank of the Lummi River in the vicinity of North Red River Road, west of Haxton Way;
- Construction of a new levee along the north bank of the Lummi River;
- Removal and relocation of portions of several existing roadways; and
- Construction of new bridges or installation of culverts on both the Nooksack and Lummi Rivers.

At March 2016 price levels, the estimated first cost of this element is $261,805,000. The estimated annual cost for operation, maintenance, repair, replacement and rehabilitation of this project element is $705,000 and is a non-federal responsibility.

c. North Fork Skagit River Delta. The reporting officers recommend a plan for the North Fork Skagit River Delta that would modify existing flood risk management dikes on both sides of the river, restore natural levees, and restore 256 acres of scarce tidal freshwater marsh. The plan will restore estuarine emergent marsh, scrub-shrub, and forested floodplain along the North Fork, improving connectivity and reducing fragmentation along the channel. Restoration at this site will improve tidal connectivity and provide critical habitat in the Skagit River, the largest and most productive river in Puget Sound. This site is included in the Puget Sound Chinook Salmon Recovery Plan. Key restoration elements at this site include the following:

- Lowering approximately 13,000 feet of levee along the south bank;
- Constructing a new levee (Rawlins Road) alignment and tying into the coastal dike system to maintain existing levels of flood risk management to surrounding land and infrastructure, including 208 structures on Fir Island;

- Lowering approximately 3,140 feet of shore armoring on the north bank;
- Breaching portions of the lowered levee and in the areas of armor removal;
- Excavating channels on both banks of the river; and
- Replanting on lowered levees in the corridor along the river from 1,700 feet upstream of the Best Road Bridge to the end of the current south bank levee system on Fir Island.

At March 2016 price levels, the estimated first cost of this element is $99,299,000. The estimated annual cost for operation, maintenance, repair, replacement and rehabilitation of this project element is $36,000.

6. Based on a March 2016 price level, the estimated project first cost of the recommended plan is $451,627,000, which includes monitoring costs of $1,090,000 and adaptive management costs of $5,307,000. In accordance with the cost sharing provisions of Section 103(c) of WRDA 1986, as amended (33 U.S.C. 2213(c)), the costs for ecosystem restoration features are shared at a rate of 65 percent federal and 35 percent non-federal. Thus, the federal share of the total project first cost is estimated to be $293,558,000 and the non-federal share is estimated at $158,069,000, which includes the costs of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD) estimated at $161,489,000. The LERRD estimate exceeds the 35% non-federal cost share for restoration features by $3,420,000 and the value of these excess LERRD may be reimbursed to the non-federal sponsor subject to the availability of funds. The Washington State Department of Fish and Wildlife is the non-federal cost-sharing sponsor for the recommended plan. Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) expenses are estimated to be approximately $863,000 per year and are the responsibility of the non-federal sponsor.

7. The average annual cost of the plan is $21,910,000. The average annual cost per average annual habitat unit is $31,000, and the average annual cost per acre is $10,000 and is a non-federal responsibility.

8. The recommended plan was developed in coordination and consultation with federal, state, and local agencies and numerous tribes. Risk and uncertainty were addressed during the study by completing a cost and schedule risk analysis and a sensitivity analysis that evaluated the potential impacts of a change in economic assumptions.

9. In accordance with Corps' guidance on the review of decision documents, all technical, engineering and scientific work underwent an open, dynamic and rigorous review process to ensure technical quality. This includes a District Quality Control review, an Agency Technical Review (ATR), an Independent External Peer Review (IEPR) (Type 1), and a Corps Headquarters policy and legal review. All comments from the above referenced reviews have been addressed and incorporated into the final documents.

DAEN
SUBJECT: Puget Sound Nearshore Ecosystem Restoration, Washington

10. The recommended plan incorporates considerations of analysis of sea level rise in accordance with ER 1100-2-8162. Estimates of sea level rise in Puget Sound range from a low of 0.4 feet to high estimates of 6.3 feet. The restoration of natural functions of the floodplains and river deltas at the recommended sites will allow the sites to adjust to changing geomorphic conditions associated with changing sea levels, e.g., shifting landward as water rises and sediment accretes.

11. Washington level review indicates the plan recommended by the reporting officers is environmentally justified, technically sound, cost effective, and socially acceptable. The plan complies with all essential elements of the U.S. Water Resources Council's Economic and Environmental Principal and Guidelines for Water and Land Related Resources Implementation Studies. The recommended plan complies with other administration and legislative policies and guidelines. The views of interested parties including federal, state, and local agencies have been considered.

12. The reporting officers identified nine additional opportunities that could provide further improvements to the Puget Sound Nearshore area. The reporting officers recommend additional feasibility level studies for Dugualla Bay; Everett Marshland; Telegraph Slough; Chambers Bay; Big Beef Creek Estuary; Tahuya River Estuary; Lilliwaup River Estuary; Big Quilcene River; and Snohomish River Estuary. Implementation of the nine additional sites would be subject to preparation of feasibility level decision documents and a favorable determination by the Secretary that the proposed projects are technically sound, cost effective, and environmentally acceptable. These feasibility studies, subject to appropriations, would be conducted under the authority of Section 209 of the River and Harbor Act of 1962, Public Law 87-874 and are expected to be compliant with Section 1001 of the Water Resources Reform and Development Act of 2014, Public Law 113–121. The cost of the feasibility studies would be shared 50% federal and 50% non-federal in accordance with Section 105 of WRDA 1986, as amended.

13. I concur in the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan for ecosystem restoration in the Puget Sound Nearshore, Washington be authorized in accordance with the reporting officers' recommended plan at a March 2016 estimated project first cost of $451,627,000. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Public Law 99-662, WRDA 1986, as amended, and in accordance with the required items of local cooperation that the non-federal sponsor shall, prior to project implementation, agree to:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:

1. Provide the required non-federal share of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs;

3. 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;

4. Provide, during construction, any funds necessary to make its total contributions equal to 35 percent of total project costs.

b. 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 that might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. 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;

d. 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;

e. 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;

f. 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;

g. 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 sponsors with prior specific written direction, in which case the non-federal sponsors shall perform such investigations in accordance with such written direction;

h. Assume, as between the federal government and the non-federal sponsors, 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;

i. Agree, as between the federal government and the non-federal sponsors, that the non-federal sponsors shall be considered the operators 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. 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.

TODD T. SEMONITE
Lieutenant General, U.S. Army
Chief of Engineers

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

January 18, 2017

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed a July 2016 Army Corps of Engineers (Corps) feasibility study of the Puget Sound Nearshore Ecosystem Restoration Project's sites at Noooksack River Delta, North Fork Skagit River Delta, and Ducakbush River Estuary in Washington with a first cost of $461,552,000 (October 2016 price level). The Congress authorized this project for construction in the Water Infrastructure Improvements for the Nation Act (Public Law 114-322).

The Office of Management and Budget appreciates the efforts to restore the nationally significant Puget Sound estuary. This highly productive estuary is the second largest in the United States and provides habitat for thirteen listed species under the Endangered Species Act. Federal, state, local, and tribal governments are invested in restoring a range of ecosystems in Puget Sound and adjacent waters, including on tributaries. We are encouraged that the Corps is working to identify and select projects for aquatic ecosystem restoration at a landscape scale and are interested in continuing discussions with you on this approach as it relates to both authorization and budgeting of projects.

The President has demonstrated a commitment to successful restoration efforts in Puget Sound, including through the establishment of the national Puget Sound Federal Task Force. This effort is consistent with the policy and programs of the President, and this project would be beneficial for river delta restoration; however, the report would be assisted by a broader framework for how to cost-effectively contribute to aquatic ecosystem restoration in Puget Sound and adjacent waters.

The Office of Management and Budget does not object to your sending this report to the Congress. When you do so, please advise the Congress that this project and its composite

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separable elements, like all other Corps projects, would need to compete with other proposed investments in future budgets.

Sincerely,

John Pasquantino
Deputy Associate Director

RECORD OF DECISION

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION, WASHINGTON

The Final Integrated Feasibility Report and Environmental Impact Statement (IFR/EIS) dated March 2016, for the Puget Sound Nearshore Ecosystem Restoration addresses ecosystem restoration opportunities in the Puget Sound nearshore zone in Washington State. The final recommendation is contained in the report of the Chief of Engineers, dated September 16, 2016. 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 recommended plan to be technically feasible, environmentally justified, cost-effective, and in accordance with environmental statutes and in the public interest.

The Final IFR/EIS, incorporated herein by reference, evaluated 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 the following:

- Duckabush River Estuary – Construction of an elevated roadway on a 2,100-foot-long bridge to replace the Highway 101 causeway and bridges across the estuary in a new alignment upstream. Removal of berms along the river and channel excavation at their historical configurations. This will restore 38 acres of floodplain delta and channel migration, and allow significant tidal exchange and distributary channel forming processes in the Duckabush River Estuary.

- Nooksack River Delta – Removal of portions of the Nooksack River's right and left bank dikes, construction of a new setback levee along the right bank, installation of large woody debris structures in the river, a new water control structure (i.e., diversion feature) installed at the confluence of the Lummi and Nooksack Rivers. Regrading the Lummi River channel will reconnect it to Nooksack River flows. On the Lummi River, the plan includes removal of a large segment of berm, construction of a new setback levee along the north bank of the Lummi River, and several road removals and/or relocations. Construction of new bridges or installation of culverts will occur on both rivers. This restores and reconnects 1,807 acres of floodplain habitat, allowing tidal exchange and shoreline complexity.

- North Fork Skagit River Delta – This project includes lowering nearly three miles of levee with several breaches along the south bank for creation of a tidal channel network, constructing a new levee along a road alignment, and lowering nearly one mile of shore armoring on the north bank. The restoration proposal includes levee lowering and excavation of new tidal channels on the eastern portion of the site on the south bank. Replanting will restore a natural riparian corridor along the river of this 256-acre site.

- The Monitoring and Adaptive Management Plan provides a framework for evaluating the effectiveness of proposed restoration actions and outlines adaptive measures if

ENCL 3

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", three restoration alternatives were evaluated in the Final IFR/EIS – Alternative #2: Restore 11 sites, Alternative #3 – Restore 18 sites, and Alternative #4 – Restore 3 sites. The three alternatives included different scales of activities at up to 18 potential restoration sites identified across Puget Sound that are critical to achieve the planning objectives of the study. Each alternative evaluated a group of potential sites for types of habitat that would be restored and overall potential restoration of functions and processes. Based on the comparison of effects presented in the IFR/EIS, Alternative #3 is the environmentally preferable alternative as it has the greatest net benefits to the biological and physical environment. However, this alternative was cost-prohibitive. Alternative #2 was identified as the tentatively selected plan or agency preferred alternative in the Draft IFR/EIS (October 2013). Alternative #4 was developed after the Draft IFR/EIS as the recommended plan based on public and agency comments and technical and cost considerations identified by the U.S. Army Corps of Engineers (Corps) and the Washington Department of Fish and Wildlife (WDFW) as the non-Federal sponsor. The recommended plan restores large acreages of significant habitat in the study area by removing long reaches of shoreline barriers, fill, and armoring, thereby restoring processes to 2,101 acres of tidally influenced wetlands and river deltas. As part of the Final IFR/EIS, the Corps and WDFW developed a master plan for restoration at 36 critically important sites around the Puget Sound nearshore zone, including the three sites in Alternative #4. The Corps and WDFW developed a tiered implementation approach to study and potentially implement the other 23 sites that were evaluated and listed in Appendix A of the Final IFR/EIS. Each site would undergo a site-specific analysis and environmental compliance prior to being recommended for construction.

All practical means to avoid or minimize adverse environmental effects have been incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EIS will be implemented. These include measures to protect water quality and minimize greenhouse gas emissions, as well as timing of construction in observance of work windows to avoid and minimize impacts to ESA-listed species and other fish and wildlife. No compensatory mitigation is required.

Pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended, the U.S. Fish and Wildlife Service (USFWS) verified in a letter dated February 4, 2016 that the recommended plan complies with the requirements of the Programmatic Biological Opinion for Fish Passage and Restoration Projects (FPRP) issued in 2008 and will not jeopardize the continued existence for species under the jurisdiction of USFWS or adversely modify their critical habitat. For species under the jurisdiction of NMFS, NMFS issued a biological opinion, dated February 11, 2016, that determined that the recommended plan will not jeopardize the continued existence of federally listed species or adversely modify designated critical habitat. All terms and conditions, conservation measures, and reasonable and prudent alternatives and measures resulting from these consultations shall be implemented in order to minimize take of endangered species and avoid jeopardizing the species.

Pursuant to section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the Corps determined that historic properties may be adversely affected by the recommended plan. The Corps, the Washington State Historic Preservation Officer, Washington Department of Archaeology and Historic Preservation, and the Lummi Nation

entered into a programmatic agreement, dated June 7, 2016. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties.

Pursuant to the Clean Water Act of 1972, as amended, any discharge of dredged or fill material associated with the recommended plan have been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act section 404(b)(1) Guidelines evaluation is found in Appendix J of the IFR/EIS. A water quality certification pursuant to section 401 of the Clean Water Act will be obtained from the Washington State Department of Ecology (WDOE) and from the Lummi Nation prior to construction. In a letter dated January 8, 2016, the WDOE stated their support of the recommended plan, pending confirmation of compliance with water quality standards based on information to be developed during the pre-construction engineering and design phase. In a letter dated November 25, 2014, the Lummi Nation similarly stated their support for the recommended plan and requested the Corps reinitiate coordination for a water quality certification based on information to be developed during the Pre-construction Engineering and Design phase. All conditions of each water quality certification will be implemented in order to minimize adverse impacts to water quality.

A determination of consistency with the State of Washington Coastal Zone Management (CZM) program pursuant to the Coastal Zone Management Act (CZMA) of 1972 will be obtained from the WDOE prior to construction. The Corps prepared a Federal CZMA consistency determination and determined the recommended plan is substantively consistent with the enforceable policies of the Washington State CZM program. The Washington State CZM program requires compliance with Clean Water Act section 401, State water quality certification. The Corps will submit the final Federal CZMA consistency determination with the water quality certification request to WDOE with the required information to be developed during the pre-construction engineering and design phase. All conditions of the consistency determination shall be implemented in order to minimize adverse impacts to the coastal zone.

Public review of the draft IFR/EIS was completed on January 8, 2015. All comments submitted were responded to in the Final IFR/EIS. A 30-day waiting period and state and agency review for the Final IFR/EIS were completed on August 15, 2016. Comments from state and Federal agencies did not result in any changes to the Final IFR/EIS.

Technical, environmental, 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 benefits of the recommended plan outweigh the costs and any adverse effects. This Record of Decision completes the National Environmental Policy Act process.

January 19, 2017
Date

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

United States Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance
1849 C Street, NW - MS 2462 - MIB
Washington, D.C. 20240

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PEP/NRM

ER 14/0656

Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-PM-ER
P.O. Box 3755
Seattle, WA 98124

Re: Puget Sound Nearshore Ecosystem Restoration, Washington State - Final Integrated Environmental Impact Statement and Feasibility Report and Draft Chief's Report

Dear Ms. Gleason:

The Department of the Interior (Department) has reviewed the U.S. Army Corps of Engineers' (USACE) Draft Chief's Report and Final Integrated Environmental Impact Statement and Feasibility Report (EIS) for the Puget Sound Nearshore Ecosystem Restoration Project (Restoration Project) in Washington.

The recommendations in the Final EIS and Draft Chief's Report for ecosystem restoration are supported by a General Investigation Study completed by USACE and the Washington Department of Fish and Wildlife. The General Investigation Study found that the large river deltas, smaller coastal embayments, and the bluff/beach systems that dominate the Puget Sound shorescape have all been widely impacted and are greatly diminished in quantity, quality, and connectivity relative to historic conditions. Numerous fish and wildlife resources rely upon these productive ecosystems and have been directly impacted by nearshore habitat loss. Estuarine wetland loss is a significant limiting factor for recovery of several species of salmonids listed for protection under the Endangered Species Act (ESA).

Final EIS

In March 2016, the U.S. Fish and Wildlife Service (FWS) provided extensive comments on the proposed Restoration Project through a Fish and Wildlife Coordination Act 2(b) Report (Coordination Act Report). This Coordination Act Report provided recommendations for minimizing potential negative impacts and maximizing intended benefits of proposed ecosystem restoration projects. Following coordination with state and federal natural resources agencies and affected tribes, the FWS supported USACE's preferred alternative/recommended plan outlined in the Draft EIS. A summary of specific conservation recommendations provided in FWS's Coordination Act Report includes:

- Adhere to best management practices and conservation measures to minimize short-term construction impacts. Avoid the need to seek variances and exceptions from practices that minimize adverse impacts to fish and wildlife resources;
- Avoid pile driving for bridge replacement features;
- Follow National Marine Fisheries Service guidelines for riparian buffers for protection of salmon habitat functions;
- Apply creativity and flexibility in working with landowners to maximize ecosystem benefits;
- Continue coordinating with tribal governments and representatives; and
- Continue to engage with the FWS through future project phases to ensure that benefits to fish and wildlife resources are maximized and short-term adverse effects are minimized.

The Final EIS, pages 282 to 283, includes FWS's Coordination Act Report recommendations and describes USACE's evaluation and implementation of the recommendations. Therefore, the Department has no further comment on the EIS.

Draft Chief's Report

The Draft EIS identified a multi-tiered strategy to implement restoration actions at 36 sites identified in the General Investigation Study. Three sites were proposed for USACE project construction authorization: Duckabush River Estuary; Nooksack River Delta; and the North Fork Skagit River Delta. In addition to these three project sites recommended for immediate authorization, the proposed tiered approach identified nine sites that could provide further improvements to Puget Sound appropriate for Water Resources Development Act (WRDA) authorization. USACE determined that restoration of these sites will require further feasibility level analysis before they could be recommended for construction authorization. Twelve project sites evaluated were determined appropriate for implementation under existing USACE's authorities, including Section 544 of WRDA 2000, Section 206 of WRDA 1996, and Section 1135 of WRDA 1986. Finally, projects at 12 other sites evaluated were determined to either be completed or more appropriate for completion by others.

In the Coordination Act Report, the FWS endorsed the tiered approach for implementing projects that address the ecosystem restoration needs documented by the General Investigation Study. The FWS stated support for:

- Immediate implementation of the alternative/recommended plan. The completion of the Nooksack River, North Fork Skagit River, and Duckabush River projects will provide substantial positive benefits to Puget Sound recovery, including important benefits for the Department's trust resources.

- Aggressive pursuit of opportunities to apply other USACE authorities to implement the 12 projects identified by the tiered approach as appropriate for Puget Sound and Adjacent Waters (Section 544) or Continuing Authority Program (Section 1135 and/or Section 206) execution. The projects that are within reach of existing authorities and resources should be implemented as expeditiously as possible.
- Developing local sponsorship funding and support to collect additional data and complete analysis required to advance the nine projects determined suitable for USACE implementation but lack sufficient information for immediate authorization.

The Draft Chief's Report adopts the alternative/recommended plan, and would advance the three identified ecosystem restoration projects for potential authorization under a future WRDA. The total acreage of wetland restoration proposed is approximately 2,100 acres. FWS finds that these projects, especially when complemented with other actions identified in the tiered implementation approach, would substantially improve Puget Sound nearshore ecosystem conditions. Restoration at this scale would contribute substantially to regional Puget Sound recovery efforts and is consistent with federal obligations to uphold treaty reserved rights of western Washington tribes. Project benefits extend to numerous species, including several protected under the ESA that rely upon estuaries and other nearshore habitats. These projects represent a significant contribution to the urgent need to recover Puget Sound ecosystems providing habitat for fish, wildlife, and plants for the continuing benefit of the American people. Therefore, the Department strongly supports the recommendations of the Draft Chief's Report.

Thank you for the opportunity to review the Final EIS and Draft Chief's Report for this project. If you have any questions concerning our comments, please contact Curtis Tanner, Manager, Environmental Assessment and Restoration Division, Washington Office of FWS, at 360-753-4326, or by email at curtis_tanner@fws.gov.

Sincerely,

Michaela Noble

Michaela E. Noble
Director, Office of Environmental Policy
and Compliance

cc: Allison O'Brien, Department of the Interior, Portland, allison_o'brien@ios.doi.gov
Curtis Tanner, U.S. Fish and Wildlife Service, curtis_tanner@fws.gov
Stefanie Stavrakas, U.S. Fish and Wildlife Service, stefanie_stavrakas@fws.gov
Patricia Bee, USACE, Patricia.L.Bee@usace.army.mil

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF THE REGIONAL ADMINISTRATOR

AUG 12 2016

Theodore A. Brown, P.E.
Chief, Planning and Policy Division, Directorate of Civil Works
Headquarters, U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3860

Dear Chief Brown:

Thank you for your letter of July 11, 2016. The U.S. Environmental Protection Agency has reviewed the U.S. Army Corps of Engineers' July 2016 Puget Sound Nearshore Ecosystem Restoration Project proposed report of the Chief of Engineers and the report of the District Engineer as well as the Final Integrated Feasibility Report and Environmental Impact Statement (EPA Region 10 Project Number: 09-061-COE).

Our review was conducted in accordance with your request for State and Agency Review and the EPA's responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act. In addition, our review reflects our recognition of Puget Sound as an estuary of national significance and the key role of PSNERP in supporting the environmental outcomes of the Puget Sound Partnership's Action Agenda as the Comprehensive Conservation and Management Plan of the Puget Sound National Estuary Program.

Congress has tasked the EPA with helping to ensure the restoration and protection of Puget Sound. Thus, the EPA has a vital interest in projects that advance this goal. PSNERP will be a major and transformative investment to restore crucial Puget Sound nearshore functions. We applaud the USACE and Washington Department of Fish and Wildlife for their leadership and perseverance in developing PSNERP over many years.

In our 2014 comments on the Draft Integrated Feasibility Report and Environmental Impact Statement, we recommended selection of the more geographically comprehensive alternative – with restoration sites in all seven of Puget Sound's sub-basins, including the Strait of Juan de Fuca, Hood Canal and South Puget Sound. We also recommended additional information on:

- the scale of PSNERP's long-term benefits relative to ongoing problems,
- lessons learned from other coastal restoration projects,
- how ongoing and predicted protection efforts by local, State, tribal or other organizations are likely to work in sync with this project's restoration efforts, and,
- how climate resiliency factored into the formulation of the final array of alternatives.

The July 2016 Final Integrated Feasibility Report and Environmental Impact Statement is responsive to our 2014 recommendations. Our highest priority recommendation was for a geographically comprehensive alternative. We recognize the Corps' and non-Federal sponsor's Puget Sound Nearshore

Implementation Strategy as being fully responsive to that recommendation.[1] The Implementation Strategy addresses our interest in geographic comprehensiveness because we agree that the strategy would allow "...for a more diversified scope of projects to be implemented under various restoration authorities of the Corps and Puget Sound Nearshore partners."[2]

At this time, we emphasize our strong support for construction authorization of a National Ecosystem Restoration Plan / Recommended Plan – as described in the Final FR/EIS and Chief's Report.[3] The NER Plan will restore aquatic ecosystem structure and function to three sites in the Puget Sound Nearshore – the Duckabush River Estuary, the Nooksack River Delta, and the North Fork Skagit River Delta. The NER Plan provides restoration of a total of 2,101 acres of aquatic habitat in the study area and provides substantial benefits to nationally significant resources.

The underlying screening process and primary driving rationale for NER Plan's three sites is robust.[4] Restoration at the Duckabush River Estuary would address habitat constraints in Hood Canal, which is a partially isolated geographic section of Puget Sound. Restoration at the Nooksack River Delta would provide 25 percent of the Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project. Inclusion of North Fork Skagit River Delta would restore floodplain and tidal connectivity in the estuary of the Skagit River, the largest and most productive river in Puget Sound.

With regard to our recommendations for additional information, we continue to believe that it is useful to understand the extent to which a restoration project or program would reverse declining trends; that lessons learned elsewhere is a priority research item; that restoration should be strategically planned to work in sync with other organizations' protection efforts; and that climate change resiliency be a decision factor. The overall PSNERP decision process, an effort involving many federal, local and state agencies and tribes as well as non-governmental organizations since 2001, is nationally exemplary and analytically sound on these and many other restoration issues.

With an eye toward next steps, we note our support for the March 2016 U.S. Fish and Wildlife Service Final Fish and Wildlife Coordination Act Section 2(b) Report's recommendations.[5] Consistent with the USFWS, we support immediate enactment of the Recommended Plan and aggressive pursuit of opportunities to apply other Corps authorities to implement the full portfolio of 12 projects identified in the Implementation Strategy. We also strongly endorse USFWS's recommendation for simultaneous work to develop local sponsorship, and support from the Corps and other agencies for additional studies to advance the remaining nine projects determined suitable for implementation, but lacking sufficient information for immediate authorization. To the extent possible, as one next step, we recommend that the Record of Decision include additional information on the Corps' plans to expeditiously implement the 12 existing authorities' projects, and simultaneously develop local sponsorship and integrated federal agency support for the nine projects requiring additional study.

Thank you for this opportunity to comment and if you have any questions please contact me or Christine

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[1] PSNERP Final FR/EIS, Appendix A
[2] PSNERP Final FR/EIS, p. *iv*
[3] Accessed online 8/8/16 at:
http://www.nws.usace.army.mil/Portals/27/docs/environmental/resources/2016EnvironmentalDocuments/PSNERP/Puget%20Sound%20Nearshore_Final-Chiefs-Report_2016.pdf
[4] PSNERP Final FR/EIS, Chapter 4
[5] PSNERP Final FR/EIS, Appendix J, pdf p. 162 (p. 44)

Littleton at (206) 553-1601or by electronic mail at Littleton.Christine@epa.gov.

Sincerely,

Dennis J. McLerran
Regional Administrator

cc: Mr. John G. Buck, Colonel, USACE
Ms. Nancy C. Gleason, Environmental Coordinator, USACE
Mr. Curtis Tanner, Local Project Manager, U.S. Fish and Wildlife Service
Ms. Elizabeth Babcock, Puget Sound Salmon Recovery Coordinator, NOAA
Ms. Sheida Sahandy, Executive Director, Puget Sound Partnership

From: Bee, Patricia L HQ02
To: Matusiak, Mark HQ02; Dunn, Angela E HQ
Subject: FW: Puget Sound Nearshore Ecosystem Restoration Project, Washington
Date: Tuesday, August 16, 2016 11:12:54 AM

NOAA response.

-----Original Message-----
From: Matthew Longenbaugh - NOAA Federal [mailto:matthew.longenbaugh@noaa.gov]
Sent: Tuesday, August 16, 2016 11:04 AM
To: Bee, Patricia L HQ02 <Patricia.L.Bee@usace.army.mil>
Subject: [EXTERNAL] Re: Puget Sound Nearshore Ecosystem Restoration Project, Washington

We support the proposed 3 nesarshore projects. ML

--

Matt Longenbaugh
Central Puget Sound Branch Chief
NOAA Fisheries West Coast Region
US Department of Commerce
Office: 360-753-7761
Mobile: 360-951-4906

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

August 8, 2016

Theodore Brown, Chief, Planning and Policy Division
Headquarters, U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Re: Puget Sound Nearshore Ecosystem Restoration Project

Dear Mr. Brown:

The Washington Department of Ecology (Ecology) appreciates the efforts by the U.S. Army Corps of Engineers (Corps) concerning the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). This type of work is very important to Ecology, whose mission is to protect, preserve, and enhance Washington's environment for current and future generations. Additionally, one of Ecology's four strategic priorities is to protect and restore Puget Sound. Because of the importance of this type of work, Ecology is a member of the PSNERP steering committee and also has been an active participant on the inter-agency teams investigating the geomorphic setting of Puget Sound shorelines, the process of bluff erosion, and the effects of armoring.

Ecology supports the continued development of the proposed project and plans. We believe these ecosystem restoration projects offer the opportunity to provide meaningful improvements to water quality while also improving marine and estuarine habitat in Puget Sound, an estuary of national significance.

Based upon the review of the proposed project during the feasibility phase and the final environmental impact statement, Ecology is optimistic that the Corps final design will include necessary measures for the protection of water quality and provide the necessary documentation to successfully move through the Section 401 Water Quality Certification and Coastal Zone Management federal consistency review processes.

Ecology is providing this letter of support for the Corps continued efforts to obtain authorization and funding for these critical restoration projects. However, be advised that this letter is not a substitute for or prejudge Ecology's decisions for the Water Quality Certification or Coastal Zone Management federal consistency, which will be issued in the future.

We look forward to continuing coordination on these proposals as you and the Washington Department of Fish and Wildlife move into the design and formal permit phase. Please contact Josh Baldi at 425-649-7010 or by email at josh.baldi@ecy.wa.gov if you have any questions.

Finally, I applaud the Corps' effort to lead an endeavor of this magnitude and look forward to continuing our partnership to protect and restore the Puget Sound ecosystem.

Sincerely,

Maia D. Bellon

Maia D. Bellon

cc: Colonel John Buck, Corps Seattle District
Jessica Winkler, Corps Seattle District

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: 600 Capitol Way N, Olympia, WA 98501-1091 • (360) 902-2200 • TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia, WA

August 15, 2016

Theodore A Brown
Headquarters, U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Puget Sound Nearshore Ecosystem Restoration Project

Dear Mr. Brown:

Thank you for the opportunity to review the draft Chief's Report and the final feasibility report and environmental impact statement for the Puget Sound Nearshore Ecosystem Restoration Project (Project). The Washington Department of Fish and Wildlife (Department), as the non-federal sponsor for the Project, is eager to move forward with the Corps on the Project and notes that implementation of the Project is consistent with the Department's regulatory authority for the protection of fish life under the Revised Code of Washington 77.55.

Implementing the recommended plan identified in the final report will make a significant contribution to the health of Puget Sound by restoring over 2,100 acres of nearshore estuarine habitat that will support multiple native fish and wildlife species. These proposed actions are a component of a larger Sound-wide effort on the part of local, state, federal, tribal and non-governmental organizations to comprehensively address the health of Puget Sound. Implementation of the recommended plan addresses Endangered Species Act-listed salmon habitat concerns and contributes to the estuary restoration target identified in the coordinated regional recovery plan (Action Agenda).

The Department notes that the draft Chief's Report is inconsistent with the June 30, 2015 memorandum signed by Mr. Steve Stockton that states:

> "The final feasibility report and draft Chief's Report will include a cost estimate to complete feasibility level analysis as well as estimated total project costs for the nine remaining sites based on best available information."

It is the Department's expectation that the final Chief's Report will be revised to include the noted cost information. The Project team has invested considerable resources to develop the existing project ideas. Acknowledging that work and capturing the costs associated with

continuing these important ecosystem restoration projects is crucial to advancing the implementation strategy for all 36 projects as captured in the above referenced memorandum.

The Department looks forward to continuing our strong partnership with the Corps. The benefits of improved nearshore habitat will be a lasting legacy for fish, wildlife, and generations of future Washingtonians. If you have any questions concerning our comments, please contact Theresa Mitchell at (360) 902-2750 or Theresa.Mitchell@dfw.wa.gov.

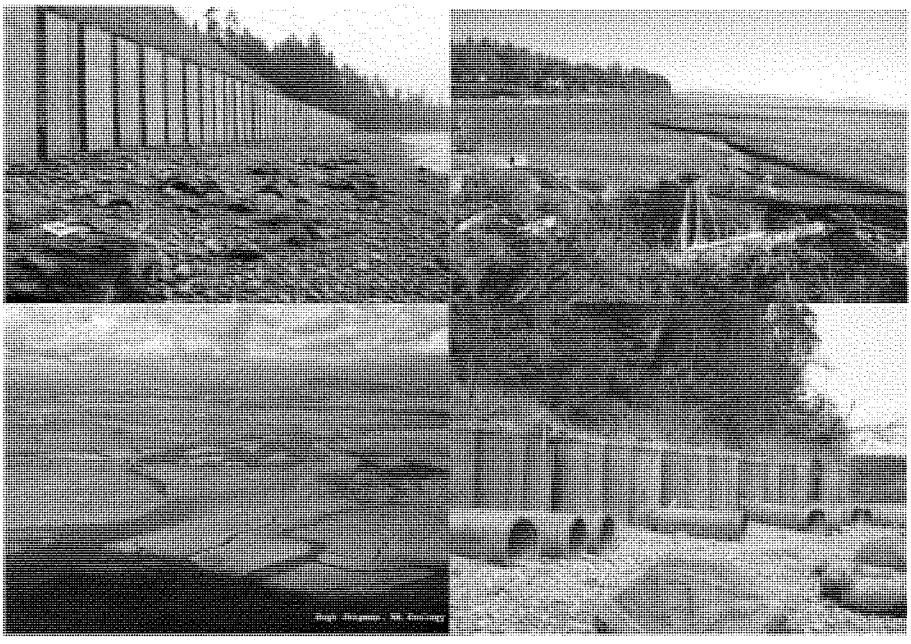
Sincerely,

James Unsworth, Ph.D.
Director

cc: Theresa Mitchell

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT



July 2016

Prepared In Support of

US Army Corps of Engineers
Seattle District

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

Washington Department of FISH and WILDLIFE

EXECUTIVE SUMMARY

The Seattle District Corps of Engineers (Corps), collaborating with the Washington Department of Fish and Wildlife (WDFW) as local sponsor, along with many other regional partners, has conducted a General Investigation (GI) to evaluate problems and potential solutions to ecosystem degradation and habitat loss in Puget Sound, Washington. The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). The Corps and local sponsor are recommending implementation of restoration actions at three sites throughout the study area as the outcome of the Nearshore Study. The estimated project first cost to restore these sites is $451,627,000 (March 2016 price level).

The Puget Sound region is characterized by steep glacially carved terrain with high mountainous regions transitioning rapidly to deep marine waters. The nearshore zone is the narrow area at the interface of terrestrial, freshwater, and marine ecosystem types that rings the Puget Sound. The nearshore zone is composed of features such as beaches, embayments, and deltas that are shaped by the interaction of coastal geomorphology and local environmental conditions (e.g., wave energy, salinity) and provides important ecological services. Due to the significant impact of human-caused changes to the nearshore zone, the zone is a strategic focus for initiatives that improve the health of Puget Sound, including this Puget Sound Nearshore Study. Analysis of this complex zone was based on guidance provided by the Nearshore Study's interdisciplinary team of scientists. The Nearshore Science Team (NST) has overseen the delivery of a series of peer-reviewed technical reports that provide the foundation of the Nearshore Study. These analyses formed the basis for identification of a problem of national significance and to planning objectives necessary to address identified issues.

Six major changes to the physical characteristics of the nearshore have been identified:

1. Large river deltas have significantly reduced in size (27% decrease in shoreline length due to tidal barriers and armoring).
2. 35% of historical coastal embayments have been lost by being filled in or disconnected by tidal barriers.
3. Sediment input has been disconnected at beaches and bluffs (over 25% of the shoreline is armored)
4. 74% of tidal wetlands surrounding the shores of Puget Sound have been lost.
5. The Puget Sound shoreline has become shorter and more artificial, decreasing in length by 15%.
6. Many shorelines are experiencing multiple stressors and cumulative impacts.

As of 2016, 13 fish and marine mammal species in Puget Sound are listed as threatened or endangered species under the Endangered Species Act (ESA). Within the study area, there are

three listed endangered species and 10 threatened species. Recovery plans for eight of the ESA-listed species have been, or are being, developed by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service. Actions proposed by the Nearshore Study support recovery of ESA-listed salmon consistent with NMFS's salmon recovery plans.

Local, State, Tribal, and Federal agencies, along with concerned citizens, nonprofit organizations, ports, and businesses recognize the need to identify nearshore ecosystem problems, evaluate potential solutions, and to restore and protect the critical ecosystem functions of the nearshore zone. The proposed actions in the Nearshore Study are integral to this comprehensive effort.

The Federal and state plan to accomplish Puget Sound recovery is the Puget Sound Action Agenda. The Action Agenda is prepared by the Puget Sound Partnership (PSP), a state agency, and is endorsed by the U.S. Environmental Protection Agency for this estuary of national significance under the National Estuary Program. In consultation with other Federal and state agencies, tribal governments, industry representatives, and others, the PSP has documented priorities for Puget Sound recovery and implementing the restoration actions proposed by the Nearshore Study is identified in the Action Agenda as a near-term priority for Puget Sound recovery. In addition, authorization and implementation of the sites included in the recommended plan would significantly contribute to the Action Agenda target of restoring over 2,100 acres of estuarine habitat by 2020. The Action Agenda has a total of 21 ecosystem recovery targets, one of which is estuarine habitat. Other Federal, state, local, Tribal, and non-governmental organizations each have a role in meeting those targets. The Corps' authorities are best suited to the restoration of aquatic habitat and therefore the nearshore zone is where the Corps is identified as having a role.

The Nearshore Study is highlighted in the Puget Sound Federal Agency Action Plan, which addresses the protection and restoration of Puget Sound and the Washington coast. The Action Plan responds to recent concerns raised by The Treaty Tribes of Western Washington about continued habitat losses and associated diminishment of treaty-protected fishery resources.

Based on principles of landscape ecology and ecological restoration, and consistent with Corps planning guidance, the Nearshore Study has identified principles for nearshore restoration that support a process-based approach. Process-based restoration includes intentional changes made to an ecosystem to allow natural processes, including unconstrained tidal hydrology, natural sediment erosion and accretion, and accumulation of driftwood, to occur. Restoration typically involves actions supporting or restoring the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., salmon production, bivalve production, and clean water). In most cases, this involves removing or modifying human-built structures that have interfered with essential ecosystem processes. Process-based restoration is distinguished from species-based restoration, which aims to improve

habitat conditions for a single species or group of species. Nearshore Study objectives seek to benefit the entire ecosystem, with associated improvements in the delivery of broader ecosystem functions and qualities.

The results of the Nearshore Study are based on a comprehensive analysis of historical and current conditions in the Puget Sound nearshore zone. Technical reports characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed through restoration. The *Change Analysis* (Simenstad et al. 2011) "is a comprehensive, spatially-explicit assessment of the extent of change over Puget Sound's shorelines, estuaries, and deltas". The Change Analysis quantified structural and physical change between historical (1850s to 1890s) and current (2000 to 2006) conditions. Building on the results of Change Analysis, the *Strategic Needs Assessment* (Schlenger et al. 2011a) developed a complementary evaluation tool to investigate the degree of degradation to nearshore ecosystem processes. Evaluation of the Change Analysis and Strategic Needs Assessment results led to identification of six major changes to the physical characteristics of nearshore ecosystems of Puget Sound. These changes can be grouped into two broad categories: 1) significant direct changes to the nearshore ecosystems of Puget Sound; and 2) widespread and pervasive changes. These observations support a science-based *problem statement* (Fresh et al. 2011), providing the basis for Nearshore Study planning objectives.

The planning objectives articulate the Nearshore Study's goal to restore the physiographic processes that sustain the Puget Sound nearshore ecosystem and associated diverse nationally and regionally significant resources. The planning objectives include the following:

- Restore the size and quality of large river delta estuaries
- Restore the number and quality of coastal embayments
- Restore the size and quality of beaches

To identify the "right places" for achieving planning objectives, the Study team developed a *strategy* for determining where process-based restoration would have the greatest likelihood of protecting and restoring ecosystem functions (Cereghino et al. 2012). The Study team has undertaken a comprehensive plan formulation process; over 500 potential restoration sites initially identified by a diverse group of restoration practitioners were systematically evaluated using habitat modeling, cost-effectiveness and incremental cost analysis, and design and cost evaluations.

After a coordinated effort to evaluate the overall ecosystem restoration strategy for Puget Sound, a tiered implementation approach was developed for 36 sites identified across Puget Sound deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and

bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and partners.

Of the 36 sites, three are recommended for construction authorization under this Corps feasibility study and are presented as the recommended plan in this report. Nine additional sites are recommended for additional study, 12 sites will be investigated by the Corps using construction authorities (Continuing Authorities Program or Puget Sound and Adjacent Waters Program), and 12 sites may be completed without Corps involvement. The figure below shows the geographical location of the 36 sites and the implementation approach for each.

Sites in the recommended plan for this feasibility report include the following:

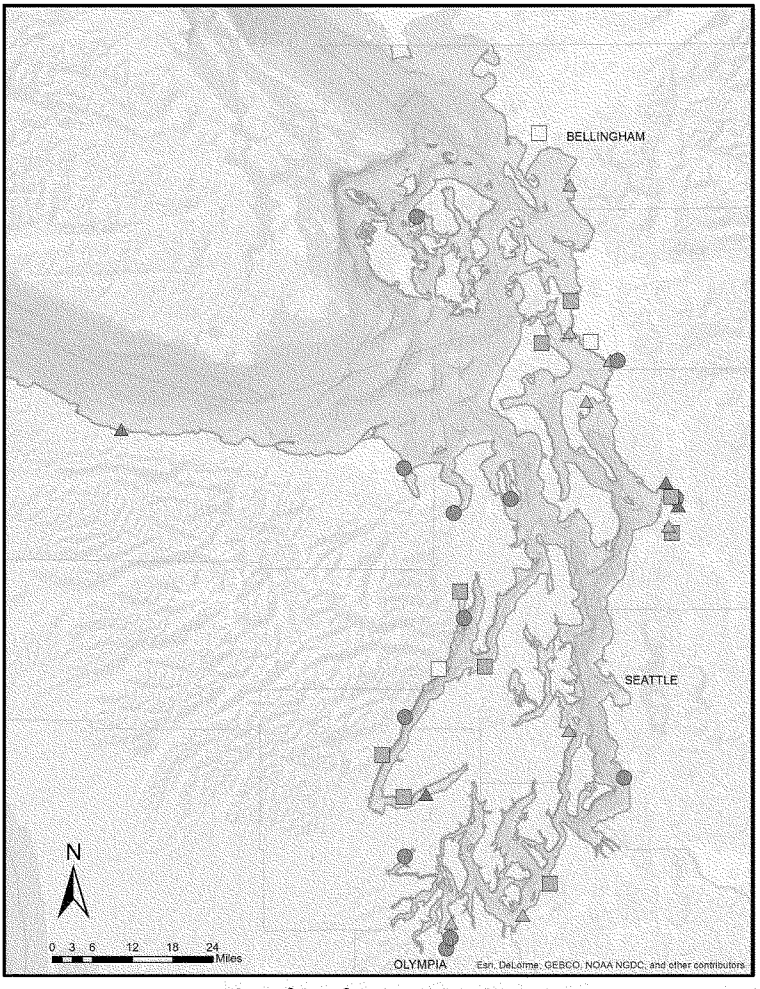
- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

The three sites included in the recommended plan for construction authorization range from 38 to 1,800 acres; total acreage of wetland restoration at the proposed sites is 2,101 acres. Costs, including final engineering design, environmental compliance, real estate, construction, and post-project monitoring, range from $91 million to $262 million per site.

Benefits from this recommended plan would derive from removing nearly 28,860 linear feet of shoreline stressors (including tidal barriers, nearshore fill, and shoreline armoring); thereby restoring processes that would restore 2,101 acres of tidally influenced wetlands in river deltas. These actions would restore wetlands that have either been lost due to fill or blocked by tidal barriers and lack sediment transport and delivery to beaches and embayments.

Restoration at the Duckabush River Estuary would address habitat constraints in Hood Canal, which is a partially isolated geographic section of Puget Sound. Restoration at the Nooksack River Delta would provide 25 percent of Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project. Inclusion of North Fork Skagit River Delta would restore floodplain and tidal connectivity in the estuary of the Skagit River, the largest and most productive river in Puget Sound.

Restoration of these three sites would support major portions of multiple recovery plans including, but not limited to the Puget Sound Chinook Salmon Recovery Plan of 2005, the Washington Comprehensive Wildlife Conservation Strategy of 2005, the Northern Pacific Coast Regional Shorebird Management Plan of 2000, and the Pacific Coast Joint Venture of 1996, and the Summer Chum Salmon Conservation Initiative. Restoration would also benefit State of Washington Priority Habitats and Species categories of wintering waterfowl, bald eagle, and native amphibians.



Tiered Implementation Strategy

- Section 544 (Puget Sound and Adjacent Waters) existing authority, $5M Federal per project limit
- Section 206 (Aquatic Ecosystem Restoration) existing authorities, $10M Federal per project limit
- PSNERP Chief's Report: 3 sites to be finalized for construction authorization
- PSNERP Chief's Report: 9 sites to be authorized for continued feasibility study
- Projects to be completed by others based on PSNERP design and analysis

Tiered Implementation Master Plan Puget Sound Nearshore Study

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1 INTRODUCTION

This report documents the planning process for ecosystem restoration of the Puget Sound nearshore zone, to demonstrate consistency with U. S. Army Corps of Engineers (Corps) planning policy and to meet National Environmental Policy Act (NEPA) requirements (40 CFR 1500-1508). The study documented herein has been conducted jointly by the Corps and the Washington Department of Fish and Wildlife (WDFW). The study is named Puget Sound Nearshore Marine Habitat Restoration, Washington (WA), in annual Energy and Water Appropriation Acts. Hereinafter, the study is called the Puget Sound Nearshore Study (Nearshore Study).

1.1 STUDY AUTHORITY*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

This Puget Sound Nearshore Study is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874), which states, "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: . . . Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources." Per this authority, a number of changed physical conditions warrant additional study of Puget Sound, Washington, and adjacent waters. A summary of these changed physical conditions is presented in section 1.8.3.

1.2 STUDY BACKGROUND

The reconnaissance phase of the study, initiated on September 29, 1999, found that there was a Federal interest in continuing the study to the feasibility phase, in accordance with guidelines in Section 905(b) of the Water Resources Development Act (WRDA) of 1986. WDFW as the non-Federal sponsor and the Corps initiated the feasibility phase of the study on September 25, 2001 through execution of a feasibility cost sharing agreement. The feasibility phase cost was shared equally between the Corps and sponsor.

1.3 STUDY AREA AND LOCATION

The waters of Puget Sound receive all of the drainage from surrounding watersheds that cover more than 16,988 square miles, collectively referred to as the Puget Sound Basin. This basin is bordered on the east by the Cascade Mountains and on the west by the Olympic Mountains. The Puget Sound Nearshore Study area consists of the nearshore zone of the Puget Sound Basin including the Puget Sound, the Strait of Juan de Fuca, and southern portions of the Strait of Georgia that occur within the borders of the United States (Figure 1-1). While the basin occurs largely within northwestern Washington State, two of its headwater drainages originate in

Canada. The study area shoreline has a length of approximately 2,500 miles. The basin is roughly 80 percent land and 20 percent water. The total water area covers nearly 3,090 square miles at mean high water.

The study area has been divided into seven sub-basins based on geographic features including oceanographic sills and bathymetry, common issues and interests of the entities in these areas, and the water flow patterns. These sub-basins are Strait of Juan de Fuca; San Juan Islands – Georgia Strait; Hood Canal; Whidbey; and North Central, South Central, and South Puget Sound (Figure 1-1). Within these sub-basins, the study area consists of the entire nearshore zone, which includes beaches and the adjacent tops of coastal banks or bluffs, the shallow waters in estuarine deltas, and tidal waters from the head of tide to a depth of approximately 10 meters relative to the mean lower low water level (Figure 1-2). This contiguous band around the shoreline of the entire study area hosts diverse ecosystems that are shaped by coastal geomorphology and local environmental conditions, such as wave energy and salinity.

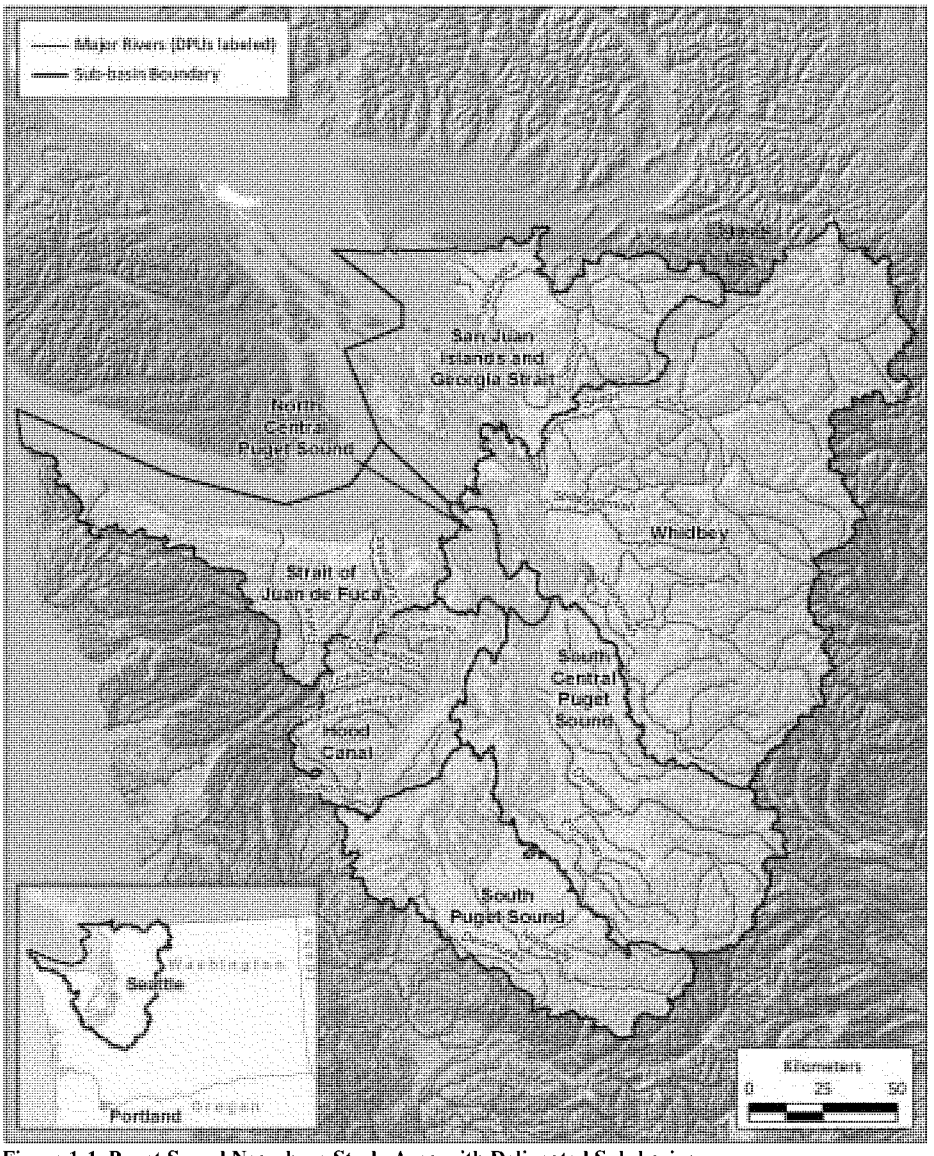


Figure 1-1. Puget Sound Nearshore Study Area with Delineated Sub-basins

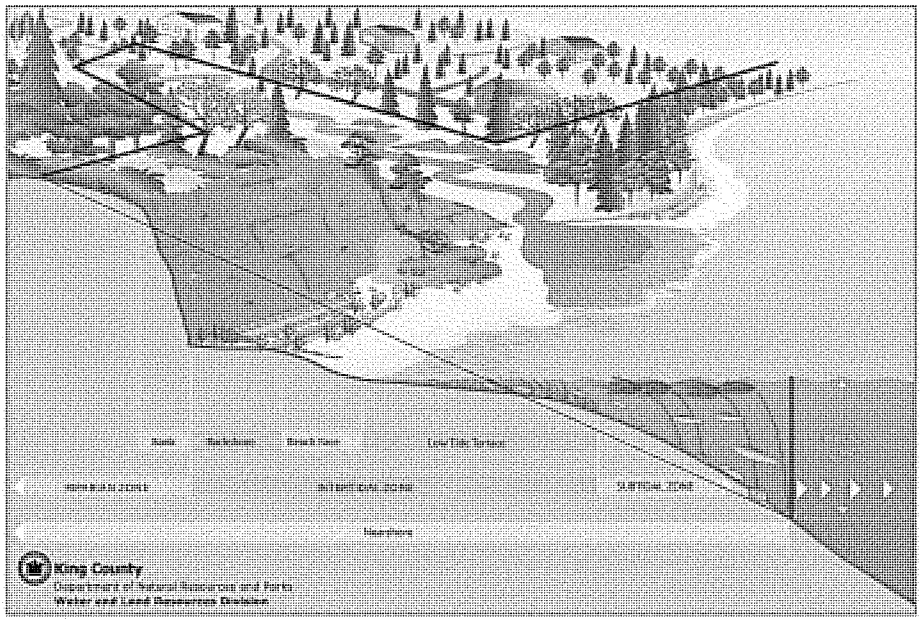


Figure 1-2. Boundaries of Nearshore Ecosystem between Riparian and Sub tidal Zones

1.4 STUDY FOCUS AND SCOPE

The focus of this study is the Puget Sound nearshore zone, the transitional zone between major ecosystem types: terrestrial, freshwater, and marine. Many of the important and unique characteristics of Puget Sound depend upon the nearshore zone, including its high biological productivity, complex food webs, diverse habitats, and large numbers of plants and animals that occupy these habitats (Kozloff 1973; Sound Science 2007). The purpose of the Puget Sound Nearshore Study is to evaluate ecosystem degradation in the Puget Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend sites that have a Federal interest and the support of a local entity willing to provide necessary local cooperation. Collectively, these restoration actions will be the recommended plan (referred to as the agency preferred alternative for NEPA compliance).

The Puget Sound Nearshore Study aims to address the continuing degradation of nearshore ecosystems through restoration of natural processes (e.g., sediment movement and tidal hydrodynamics) and restoration and/or re-creation of coastal wetlands and embayments. Scientists have extensively studied the historical character of the marine shoreline to understand the natural processes that sustain the ecosystem. Restoration projects will be designed to advance the natural processes that occur at specific sites working within the constraints of their adjacent

landscape. The Puget Sound Nearshore Study does not formally consider other types of environmental concerns in Puget Sound, such as those related to water quality, contaminants, storm water, or land use management. These concerns are taken into consideration during the evaluation of alternatives, as they may affect the success or failure of projects proposed as part of the Nearshore Study, but they are being formally addressed outside of this study through other federal and state initiatives. The Project Delivery Team (PDT) is a multi-disciplinary, multi-agency team responsible for the successful development and execution of all aspects of the study. Composition of the PDT also referred to as the study team appears in Chapter 8.

1.5 PURPOSE AND NEED FOR PROPOSED ACTION*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

The purpose of the proposed action is to restore the natural processes in the nearshore zone that sustain the biological, economic, and aesthetic resources important to the people of the Puget Sound region and the nation in a cost-effective and socially feasible manner with minimal risks, and to facilitate effective monitoring and adaptive management to maximize attainment of restoration objectives.

The Puget Sound region is home to approximately 4.3 million people, about 70 percent of Washington State's population, and has become the economic hub of the northwestern United States and an American global trade center on the Pacific Rim. Many of the region's natural resources play a major role in the economic well-being and standard of living in the area. A healthy Puget Sound is integral to the regional economy. Chapter 3 of this report provides a detailed account of nearshore ecosystem problems that have given rise to the need for a comprehensive restoration effort requiring the assistance of the Federal Government.

The need for the proposed action comes from recognizing that valuable natural resources in Puget Sound have declined to a point that the ecosystem may no longer be self-sustaining without immediate intervention to curtail significant ecological degradation. Impairment of nearshore processes and degradation of ecosystem functions are critical factors in the declining health of Puget Sound. Anthropogenic stressors causing this impairment and degradation include the direct effects of physical alterations to the landscape that have eliminated large expanses of habitat and have disrupted the major ecological processes that create and sustain habitats (see section 1.8.4 for more information on stressors). The degradation and loss of nearshore ecosystems is of critical importance because the nearshore zone serves as the connection between terrestrial, freshwater, and marine ecosystems. This means that the nearshore zone vitality, resilience, and productivity influence the productivity of the entire Puget Sound Basin. The alterations to the physiographic processes of the nearshore zone directly affect the ecosystem functions upon which humans depend such as fisheries, aquaculture, and recreation.

As of 2016, 13 species in Puget Sound are listed as threatened or endangered species under the Endangered Species Act (ESA). Within the study area, there are three endangered and 10

threatened species. Many of the ESA-listed species in Puget Sound impacted by habitat loss or degradation would benefit from restoration actions, either directly by using the restored habitat (as is the case for listed salmonids) or indirectly via reliance of their prey on the habitat (as is the case for killer whales and murrelets).

Local, state, tribal, and Federal agencies, along with concerned citizens, nonprofit organizations, port authorities, and other entities recognize the need to identify nearshore ecosystem problems, evaluate potential solutions, and restore and protect the critical ecosystem biodiversity and productivity of the nearshore zone. Because of the inherent complexities associated with the Puget Sound nearshore zone (i.e., varied ownership, mixed land use), large-scale ecosystem restoration options are beyond the capabilities of private entities, non-governmental organizations, or local governments and are more suited to Federal interests playing a key role in a coordinated restoration effort. The Corps is well suited to take the lead on this large-scale restoration effort and has the ability to use expertise in water-related resource problems to seek construction authority on restoration efforts in the nearshore zone.

1.6 PROPOSAL FOR FEDERAL ACTION

The Federal government's proposal to authorize, fund, and implement ecosystem restoration at sites in the Puget Sound Basin triggered the NEPA process recorded in this document (40 CFR 1501.2). The Corps is proposing a suite of ecosystem restoration sites around the Puget Sound nearshore zone. The Nearshore Study has identified principles for nearshore restoration that support a process-based approach. Process-based restoration typically involves actions supporting or restoring the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., biological productivity and clean water). In most cases, this involves removing or modifying human-built structures that have interfered with essential ecosystem processes. The types of nearshore features identified for restoration include freshwater and tidal wetlands, coastal embayments, intertidal mudflats, reconnection of estuarine tidal channels, and sediment delivery from bluff-backed beaches. Restoration of these features and natural processes requires construction work to remove human-built structures that have reduced ecosystem functions in the nearshore zone. Alternatives are presented and analyzed in section 4.6 (40 CFR 1502.14). In addition to the proposed construction projects, the Corps created a plan to ensure that monitoring and adaptive management are applied appropriately and efficiently. The monitoring and adaptive management plan is described in section 6.4.

1.7 PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

The Corps' Seattle District has conducted other general investigations and has implemented other ecosystem restoration projects around Puget Sound prior to initiating the Puget Sound Nearshore Study. Lessons learned and data from these studies have been incorporated into the Puget Sound Nearshore Study where appropriate.

1.7.1 Corps Studies in the Puget Sound Area

General investigation studies underway in the Puget Sound region are listed in Table 1-1.

Table 1-1. General Investigations Underway in the Puget Sound Area

Study Name	Purpose	Description
Skokomish River General Investigation (Chief's Report signed Dec. 2015)	Ecosystem Restoration	Investigate restoration measures along the Skokomish River, which drains to Hood Canal, a naturally formed fjord of the Puget Sound Basin.
Puyallup River General Investigation	Flood Risk Management	Investigate flood risk management measures along the Puyallup River, which drains to Commencement Bay, Puget Sound.
Seattle Harbor General Investigation	Deep Draft Navigation	Investigate navigation improvements to the East and West Waterways of Seattle Harbor.

1.7.2 Corps Ecosystem Restoration Projects in the Puget Sound Area

Authorized and/or completed restoration projects in the Puget Sound area appear in Table 1-2.

Table 1-2. Corps Ecosystem Restoration Projects in the Puget Sound Area

Project Name	Authorization	Description
Puget Sound and Adjacent Waters Restoration Program (PSAW)	PSAW - WRDA[a] 2000	Restoration studies underway include a Dungeness River ecosystem restoration site.
Qwuloolt Ecosystem Restoration	PSAW - WRDA 2000	Restored tidal processes to 400 acres of previously diked pasturelands.
Seahurst Beach Restoration Phases 1 and 2	PSAW - WRDA 2000	Phase 1 construction was complete in 2005. Phase 2 construction was complete in August 2014. This restored approximately 1 mile of nearshore habitat through removal of shoreline armoring.
Stillaguamish River Ecosystem Restoration Project	WRDA 2000	Restoration of 10 sites along the Stillaguamish River including three estuary sites.
Green-Duwamish Ecosystem Restoration Project	WRDA 2000	Authorizes 45 site-specific (including 3 estuary sites) and programmatic restoration sites throughout the Green-Duwamish River Basin. Six projects have been completed, one is currently under construction, and one more is nearing the construction phase.
Deepwater Slough Estuarine Restoration Project – Phase 1	Section 1135[b]	Deepwater Slough was the largest estuarine restoration project in Puget Sound when it was implemented, opening 230 acres of intertidal and tidal channel habitat.
Carpenter Creek Estuarine Restoration Project	Section 206[c]	The project was authorized to improve tidal flushing at two undersized culverts, reduce tidal velocities, remove fish passage barriers, and reduce habitat fragmentation restoring 22 acres of estuarine and salt marsh habitat. The local sponsor constructed this project.

Project Name	Authorization	Description
Green/Duwamish River (at Codiga Farms site) Restoration Project	Section 1135	This project created 830 linear feet of side-channel rearing habitat for juvenile salmon, a half-acre estuarine marsh, and 1.6 acres of riparian and upland planting to support wildlife.
Green/Duwamish River Turning Basin (at Hamm Creek) Restoration Project	Section 1135	The project restored a highly degraded tributary to the Duwamish River including a new 1,000-foot channel with soil amendments and plantings.
Lake Washington Ship Canal Smolt Passage Project	Section 1135	The project implemented numerous measures to minimize abrasion injury and mortality to juvenile salmon including installation of smolt flumes over the dam.
Union Slough Restoration Project	Section 1135	The project breached levees and opened 35 acres to tidal influence in the Snohomish River Estuary.

a. WRDA – Water Resources Development Act
b. Section 1135 of the Water Resources Development Act of 1986
c. Section 206 of the Water Resources Development Act of 1996

1.8 PUGET SOUND NEARSHORE STUDY SYSTEMS APPROACH

Corps guidance (Engineer Pamphlet [EP] 1165-2-502 [USACE 1999a]) states, "ecosystem restoration is a primary mission of the [Corps] Civil Works program. ... the purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. Improving the long-term survival of self-sustaining systems delivers improved conditions for fish and wildlife resources."

The Puget Sound Nearshore Study approach is consistent with Corps policies on ecosystem restoration planning. The study bases its investigation on numerous scientific studies and findings that recognize ecosystem processes as key system drivers that, if degraded, have long-lasting, spatially extensive effects on biological communities. While difficult to assess directly, ecosystem processes are manifested in the natural landforms that they create and maintain. By completing detailed characterizations of marine landforms using historical and current data, and projections of future conditions, the Puget Sound Nearshore Study team has been able to infer the state of natural process degradation within Puget Sound. These findings serve as the condition that can be expected in Puget Sound if a project is not authorized and implemented. Figure 1-3 shows the major documents associated with plan formulation of the Nearshore Study. These technical reports are available for download at *www.pugetsoundnearshore.org*.

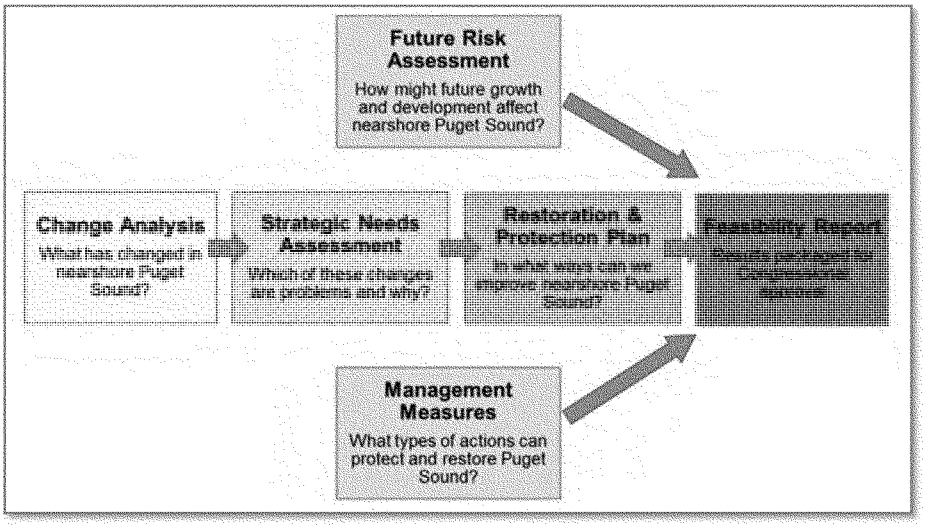


Figure 1-3. Supporting Documents in the Nearshore Study Planning Process

1.8.1 Process-based Restoration

Ecosystem processes are the interactions among physiochemical and biological elements of an ecosystem that change in character or state over time (Fresh et al. 2004). Processes operate at naturally occurring rates, frequencies, durations, and magnitudes that are controlled by human and natural factors (Goetz et al. 2004). Human attempts to control dynamic coastal systems (such as beaches, bluffs, floodplains, and river deltas) using structural approaches (such as groins, bulkheads, dikes, and levees) disrupt the natural processes and degrade nearshore ecosystems. Restoration actions aimed at restoring damaged processes enable the ecosystem to be naturally productive, self-sustaining, and diverse (Goetz et al. 2004).

The Puget Sound Nearshore Study has identified guiding principles for nearshore ecosystem restoration that favor process-based restoration over species-based restoration (see sidebar). Key physical processes such as tidal hydrology and sediment supply are understood to be essential to biotic function. The study identifies three main reasons for favoring process-based restoration (Simenstad et al. 2006):

- Without restored processes, the long-term maintenance of the structure and its associated ecological functions is highly uncertain.
- The processes are inherently involved in the functions to be recovered.
- Incorporating or accepting natural ecosystem dynamics is less likely when considering only the function an ecosystem provides to a single species.

A detailed discussion of a process-based restoration approach, as applied by the Puget Sound Nearshore Study, is provided in "Introduction and Background" of the Management Measures Technical Report (Clancy et al. 2009).

Process-based restoration includes intentional changes made to an ecosystem to allow natural processes (such as erosion, accretion, accumulation of wood debris, etc.) to occur. This restoration typically involves actions supporting or restoring the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., salmon production, bivalve production, and clean water). Process-based restoration is distinguished from species-based restoration, which aims to improve the services an ecosystem provides to a single species or group of species as opposed to improving elements that support the entire ecosystem.

Alterations to natural processes alter nearshore ecosystem habitats (e.g. river deltas, beaches, and coastal embayments) that provide ecosystem biological and geochemical functions. These functions can be largely categorized as biodiversity, plant and animal productivity, soil fertility, water quality, and many other local and global environmental conditions. Human alterations of structures and functions affect these life-supporting components.

1.8.2 Conceptual Model Used to Support Process-Based Restoration

The Puget Sound Nearshore Study approach to process-based restoration relies upon conceptual models explaining the linkages between nearshore ecosystem processes, structures/systems, habitats, and ecological functions. These linkages, depicted in Figure 1-4 for Puget Sound beaches, are based on the Puget Sound Nearshore Study's underlying scientific hypothesis that "alterations of natural hydrologic, geomorphologic (i.e., pertaining to geological structure), and ecological processes impair important nearshore ecosystem structure and functions" (Simenstad et al. 2006).

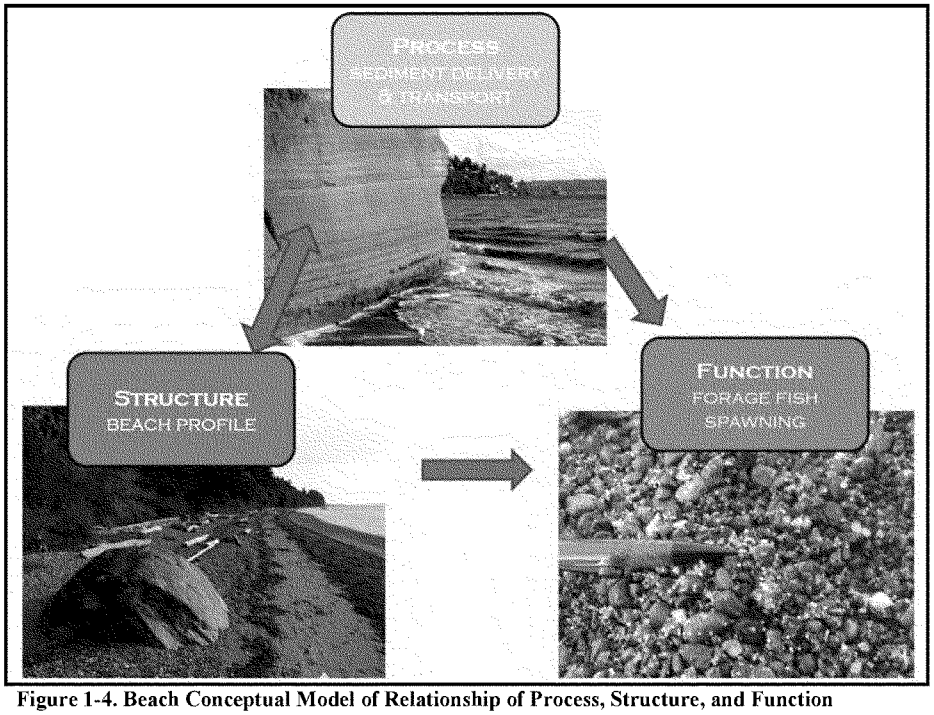


Figure 1-4. Beach Conceptual Model of Relationship of Process, Structure, and Function

1.8.3 Change Analysis

The change analysis of the Puget Sound nearshore zone (Change Analysis; Simenstad et al. 2011) serves as ". . . a comprehensive, spatially explicit assessment of the extent of change over Puget Sound's shorelines, estuaries and deltas." The change analysis report provides a detailed discussion of the Study team's approach and results in assessing change between historical and current conditions. The report provides detail on data structure and components for the Puget Sound-wide geodatabase assembled for this analysis (Simenstad et al. 2011).

The Change Analysis quantified structural and physical change between historical (ca. 1850s – 1890s) and current (ca. 2000 – 2006) conditions. This analysis correlates the location, occurrence, and amount of stressor impacts on nearshore ecosystems in the context of dominant ecosystem processes. Finally, the analysis interpreted the spatially explicit significance of the various changes and stressors in terms of impairment to ecosystem functions.

To provide a spatially explicit accounting of nearshore ecosystem process changes, the Puget Sound shoreline was delineated into geomorphically similar segments (landforms) based on the adopted geomorphic classification system (Shipman 2008). This classification provided the basis

for independently classifying both historical and current landforms that reflect varying sedimentation processes (beaches) and freshwater inflow and tidal mixing (estuaries/deltas) as the dominant controlling factors.

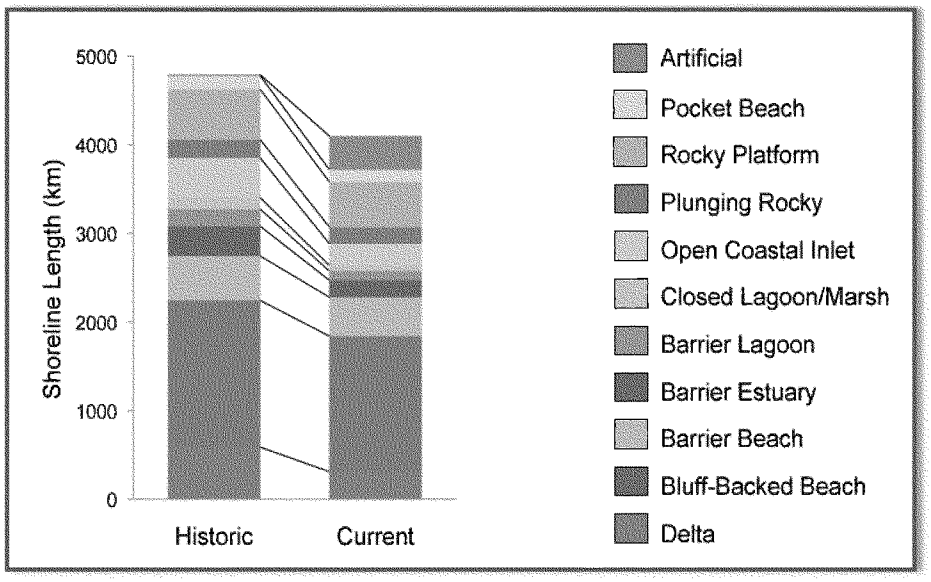


Figure 1-5. Puget Sound-wide Landform Transitions (from Simenstad et al. 2011)

The resulting change analysis geodatabase documents changes over the (current) approximately 2,466 miles of Puget Sound shoreline and corresponding 13,930 square miles of drainage area. Historical change was analyzed for each identified process unit (shoreline reach associated with a littoral drift cell) in Puget Sound, as well as in each sub-basin. Change data is tabulated and mapped in a variety of analytical outputs at the individual process unit level and summarized within Puget Sound sub-basins, among sub-basins, and Sound-wide. An example graph showing landform transition from historic to current at the Puget Sound-wide scale appears in Figure 1-5.

1.8.4 Strategic Needs Assessment

The purposes of the strategic needs assessment (Schlenger et al. 2011a) were to characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed in this feasibility study through restoration and protection alternatives. Specifically, the assessment does the following:

- Explains the impacts of stressors (human alterations) along shorelines and in watersheds on the nearshore processes that create and sustain the ecosystems.
- Explains the resulting effects of the impacted nearshore processes on nearshore habitat structures and functions.
- Presents a spatial analysis that applies a set of rules to assess nearshore ecosystem process degradation resulting from human alterations to physical conditions along the shoreline and throughout the watershed.
- Uses spatial analysis outputs to identify and characterize locations and magnitudes of degradation of nearshore ecosystem processes Sound-wide and in each of the sub-basins.
- Presents a discussion of the major physical changes and problems affecting the overall function of the Puget Sound nearshore ecosystems.
- Identifies recommended priorities for locations and nearshore processes to be addressed through restoration and conservation.

While the change analysis results identify ecosystem impairment, Schlenger et al. (2011a) developed a complementary methodology to investigate the degree of degradation to nearshore ecosystem processes as part of the strategic needs assessment. To develop this tool, the Study team documented scientific understanding of the impacts that shoreline and upland stressors (human alterations) have on nearshore ecosystem processes, habitat structures, and functions. For each stressor, a separate section of the strategic needs assessment report was prepared, using available scientific literature to explain the linkages among stressors, processes, structures, and functions. In addition, each section described the impacts of the stressors on socially important biota and habitats, and the distribution of the stressor throughout Puget Sound and its sub-basins.

Table 1-3. Nearshore Stressors

Stressor	Description
Tidal barriers	Structures (e.g., dikes and levees) designed to impede tidal flow
Nearshore fill	Material placed below the ordinary high water mark (OHWM) to create upland area
Shoreline armoring	Shore-parallel erosion control structures, such as bulkheads and rock revetments
Nearshore railroads	Active and abandoned railroads within 25 meters of the shoreline
Nearshore roads	Roads along the shoreline and within 25 meters of the shoreline
Marinas	Temporary and permanent boat slips, and associated in-water facilities to accommodate vessel moorage and upland support facilities
Breakwaters and jetties	Structures designed to mitigate the impact of wave energy
Overwater structures	Large industrial/commercial docks, single-family residence docks, floating docks, fixed piers, bridges, floating breakwaters, moored vessels
Dams	Barriers that block the flow of water in a stream or river channel
Stream crossings	Places where transportation corridors (i.e., roads and railroads) cross rivers, streams, and estuaries
Impervious surfaces	Pavement, buildings, and other largely impermeable areas
Developed land cover	Type of human feature present on the surface of the earth

The 12 stressors considered in the Nearshore Study (Table 1-3) were limited to those physical stressors for which sufficient Sound-wide data were available. Some of these stressors lie directly along the nearshore zone, while some are features within the contributing watershed.

The strategic needs assessment presents a process evaluation framework used to assess the degree of degradation for each of the nearshore ecosystem processes. This framework assesses co-occurrence of stressors that degrade ecosystem processes along the portions of the nearshore zone that support these important processes. An overall characterization combining the observed degradation of all 12 processes was presented for shoreline and delta process units (Figure 1-6).

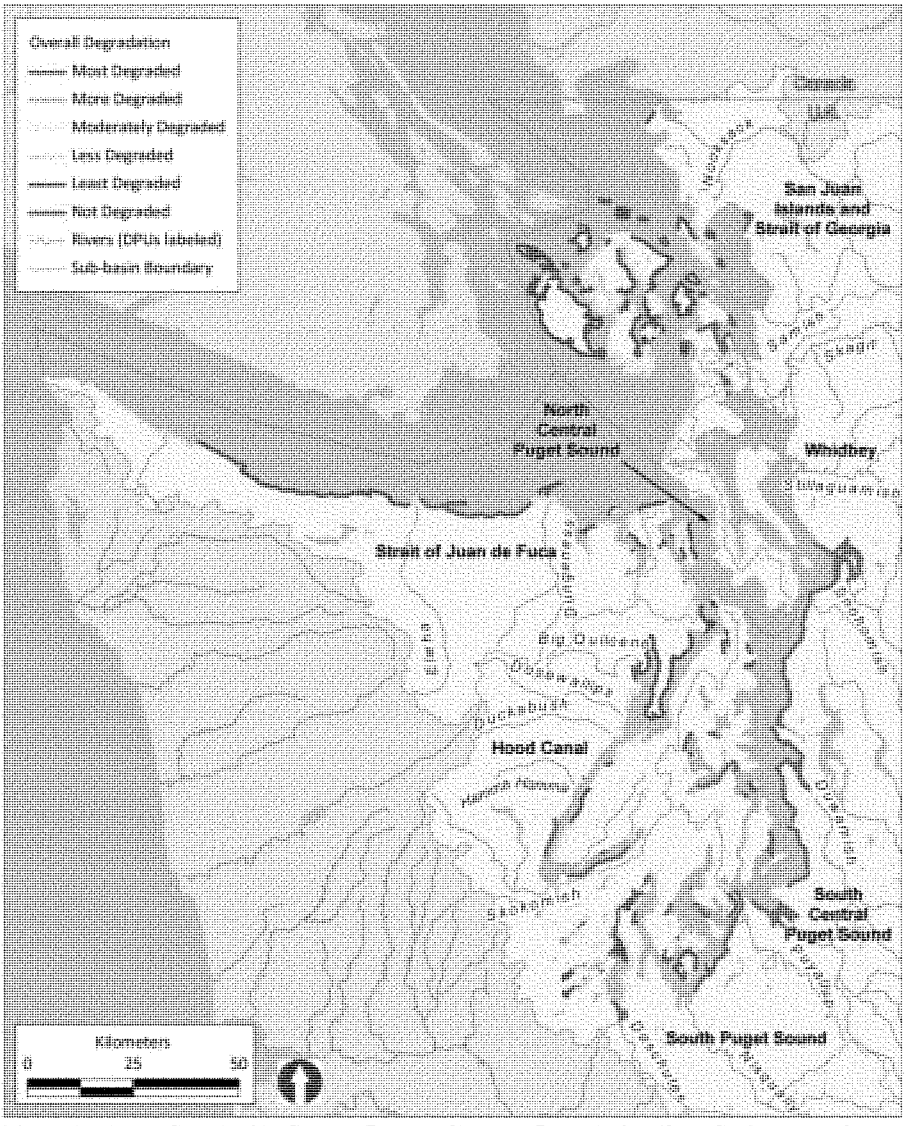


Figure 1-6. Puget Sound-wide Current Degree of Process Degradation (from Schlenger et al. 2011a)

1.8.5 Problem Statement

The Nearshore Science Team (NST; see section 8.1.3 for a description) identified six major changes to the physical characteristics of the nearshore ecosystems of Puget Sound, based on the team's evaluation of findings in the change analysis and the strategic needs assessment. These changes are described in a comprehensive document referred to as "the problem statement" (Fresh et al. 2011). Changes have two broad categories: 1) direct changes to nearshore ecosystems; and 2) widespread and pervasive changes. These observations support a science-based problem, providing a focus for evaluating restoration alternatives and formulating a plan.

Significant direct changes to nearshore ecosystems include the following:

- Large river deltas have been widely impacted by multiple alterations that significantly limit the size of the estuaries and degrade the nearshore ecosystem processes that support them. For the 16 largest river deltas in Puget Sound combined, shoreline length has declined nearly 27% from historical conditions (Fresh et al. 2011).
- Many coastal embayments, including open coastal inlets, barrier estuaries, barrier lagoons, and closed lagoons/marshes, have been eliminated or disconnected from Puget Sound by the placement of fill, tidal barriers, and other stressors. Puget Sound has experienced a loss of 305 embayment landforms (from 884 under historical conditions to 579 currently). The length of embayment shoreline in Puget Sound declined nearly 46% (Fresh et al. 2011).
- Stressors along beaches and bluffs have disconnected sediment inputs and altered sediment transport and accretion along long sections of the Puget Sound shoreline. Approximately 27% of the shoreline of Puget Sound is armored; 59% of divergent zones (a major source of sediment to Puget Sound beaches) have some armoring associated with them (Fresh et al. 2011).
- Estuarine wetlands have been extensively lost throughout Puget Sound, including a loss of 56% in the 16 largest river deltas. In particular, oligohaline (i.e. low saltwater concentration) and freshwater tidal wetlands have been almost completely eliminated (loss of 93%) in Puget Sound (Fresh et al. 2011).

Widespread and pervasive changes include the following:

- The shoreline of Puget Sound has become much shorter and simpler, as well as more artificial. Since Europeans began settling the region, Puget Sound's shoreline has had a net decline of 15% in length due to hardening the shoreline, as well as closing off bays and estuaries for development of homes and businesses. Artificial landforms now represent 10% of the shoreline of Puget Sound (Fresh et al. 2011).
- Large portions of Puget Sound have been altered by multiple types of changes that may cumulatively combine to severely degrade nearshore ecosystem processes. Approximately 40% of the shoreline of Puget Sound has been altered by a stressor (e.g., overwater

structures, roads, marinas, etc.). Only 112 of 828 shoreline segments (encompassing all of Puget Sound's shoreline with the exception of large deltas) have no stressor associated with them (Fresh et al. 2011).

The cumulative effects of these multiple human-induced stressors threaten to overwhelm the ability of naturally occurring ecosystem processes to maintain structures, biological resources, and ultimately, the biodiversity and productivity provided by the ecosystem. Thus, the synergistic efforts of restoring the nearshore processes, structures, and functions must be thoroughly coordinated and pursued simultaneously with other restoration efforts, such as the protection of water quality, freshwater resources, good land use practices, and human health.

The effects of ecosystem degradation and potential restoration opportunities are illustrated in Figure 1-7 and Figure 1-8. These images show a typical Puget Sound nearshore site not included in this study, Seahurst Beach, as a reference condition for similar sites under consideration in the Nearshore Study. These figures illustrate the site in a formally degraded condition followed by restoration of approximately 2 miles of nearshore habitat through removal of shoreline armoring. These images depict the typical types of degraded processes in the nearshore zone as well as a reference condition for a site that has undergone process-based restoration.

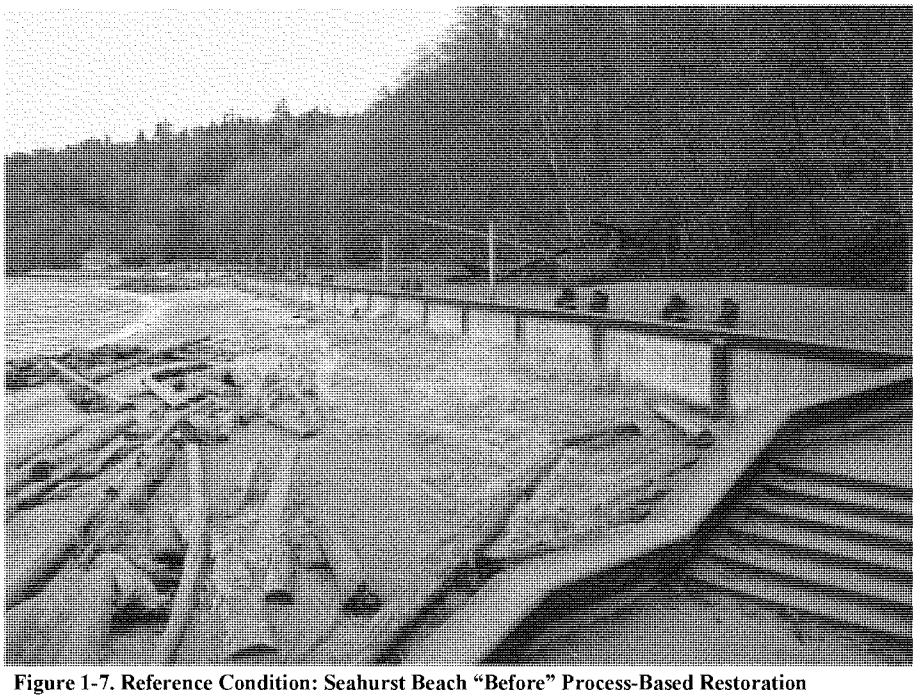


Figure 1-7. Reference Condition: Seahurst Beach "Before" Process-Based Restoration



Figure 1-8. Reference Condition: Seahurst Beach "After" Process-Based Restoration

1.8.6 Restoration and Protection Strategies

To inform restoration and protection strategies so that actions are directed toward "sites where we can best protect and restore nearshore ecosystem services", Cereghino et al. (2012) have further evaluated the results of the change analysis and the strategic needs assessment. This evaluation seeks to answer the following questions about nearshore ecosystem restoration and protection:

1. Where should we try to recover the ecosystem services we have lost?
2. How should our approach respond to the variable conditions found in the landscape?
3. How should we consider an individual project as part of a cohesive landscape strategy?
4. What kinds of opportunities and risks should we keep in mind as we work in different settings?

By applying principles proposed by Goetz et al. (2004) and ecosystem restoration theory reviewed by Greiner (2010), river deltas, beaches, barrier embayments, and coastal inlets were categorized based on attributes of opportunity, degradation, and risk. Statistical treatment of these attributes suggests organizing sites into groups in which management strategies of protection, restoration, or enhancement are most likely to be successful (Figure 1-9). These recommendations are identified for each landform type (e.g., beaches or embayments), but not across types. The authors (Cereghino et al. 2012) explain, "Our strategies do not attempt to compare deltas to beaches or beaches to inlets. We need deltas, beaches, embayments, and inlets to restore historical ecosystem services in the nearshore zone. The physical structure of the landscape defines landform, and the potential for a landscape to provide these services."

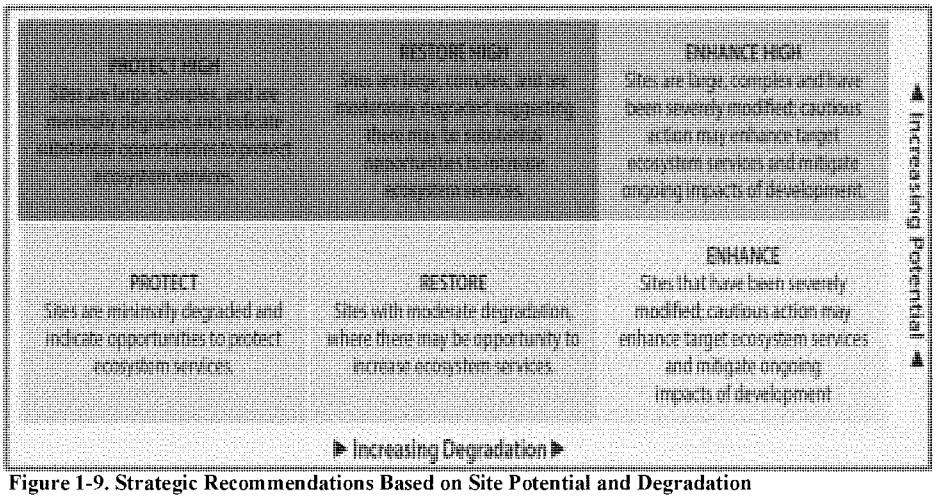


Figure 1-9. Strategic Recommendations Based on Site Potential and Degradation

In evaluating potential restoration actions, the Study team used preliminary results from the Restoration and Protection Strategies evaluation, hereafter called the "Strategies Report" (Cereghino et al. 2012), to determine whether each proposal could support restoration objectives with the "right action in the right place." Please note that Figure 1-3 refers to this Strategies Report as the "Restoration and protection Plan". The Corps focuses on areas of high restoration potential while other entities may choose to focus on addressing areas of high protection potential and/or high enhancement potential. More detail on this concept is provided in section 4.1.

1.9 REPORT ORGANIZATION: INTEGRATION OF NEPA COMPLIANCE & THE PLANNING PROCESS

This document is an integrated 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 adverse environmental effects of the alternatives and to incorporate environmental concerns into the decision-making process.

1.9.1 The 6-Step Corps Planning Process and NEPA Requirements

The six steps of the Corps planning process each align with a NEPA requirement. The planning steps are listed below followed by the document chapter and NEPA element to which they relate:

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 3
Step Three: **Formulate Alternative Plans**	Alternatives including Proposed Action; Chapter 4
Step Four: **Evaluate Effects of Alternative Plans**	Environmental Consequences; Chapter 3
Step Five: **Compare Alternative Plans**	Alternatives including Proposed Action; Chapter 4 and 5
Step Six: **Select Recommended Plan**	Agency Preferred Alternative; Chapter 6

1.9.2 NEPA Scoping and Identification of Issues*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

Scoping took several forms for this study. The various committees of the Nearshore Study consist of regional experts in natural resources and ecosystem restoration programs; these individuals and committees have been discussing the significance of issues related to the project throughout the life of the Study, and those concepts are captured within this document. Additionally, the primary project delivery team consulted natural resource agencies such as NMFS and USFWS, and held internal meetings to discuss the scope of issues included in this report. Furthermore, the Corps and WDFW hosted public meetings to solicit comments about this project. The comprehensive list of activities is detailed in section 8.3. The significant resources identified for detailed analysis are described in Chapter 3 and the effects of the alternatives on these resources are compared in Chapter 5.

2 NEED FOR AND OBJECTIVES OF ACTION

This chapter lays out the objectives for this ecosystem restoration project and explains their importance. The chapter begins with a statement of the Federal objective that underlies Corps ecosystem restoration efforts. Next, this chapter addresses how the resources that comprise the ecosystem are recognized as significant institutionally, technically, and publicly. The Problems and Opportunities section explains how the ecosystem has been affected, and describes opportunities the Nearshore Study has identified to address those problems. Finally, this chapter identifies planning objectives and constraints that guide plan formulation described in Chapter 4.

2.1 THE FEDERAL OBJECTIVE

The purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. The intent of ecosystem restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system.

2.2 SIGNIFICANCE OF RESOURCES: TECHNICAL, INSTITUTIONAL, PUBLIC

The Puget Sound and its nearshore zone include resources that are technically, institutionally, and publicly significant as summarized below and described in the following sub-sections:

- Puget Sound and its adjacent waters support the largest area of remaining estuarine wetlands on the West Coast, exceeding the combined total area of Columbia River and San Francisco Bay estuarine wetlands by over 30%. Because of its size, tidal exchange, and freshwater inputs, Puget Sound supports more than twice the primary productivity of Chesapeake and San Francisco bays combined, supporting a corresponding biodiversity and secondary productivity of flora and fauna (Emmett 2000, USACE 2004).

- Recognizing its uniqueness, the U.S. Environmental Protection Agency (EPA) designated Puget Sound as an "Estuary of National Significance" in 1988. To date, 28 estuaries have this designation. According to EPA, one of the many benefits of the National Estuary Program (NEP) is that they "share information about their successful approaches to environmental challenges with each other and other coastal watershed managers". That exchange is critical to the effective restoration and protection of estuarine health across all the NEPs.

- The Puget Sound Action Agenda is the Federal and state roadmap for restoring the health of Puget Sound by 2020. Proposed restoration by PSNERP is an integral component to achieving Action Agenda recovery targets. The Action Agenda has been approved by EPA as the Comprehensive Conservation and Management Plan for Puget Sound under the EPA's NEP and has been endorsed by the Puget Sound Federal Caucus (which includes the Corps of Engineers). The Action Agenda has a total of 21 ecosystem recovery targets, one of which is

estuarine habitat. Other Federal, state, local, Tribal, and non-governmental organizations each have a role in meeting those targets. The Corps' authorities are best suited to the restoration of aquatic habitat and therefore the nearshore zone is where the Corps is identified as having a role.

- Nearshore restoration actions that improve habitat function are critical to the recovery and protection of tribal treaty right resources, such as fish and shellfish, in Puget Sound. *US v. State of Washington* and sub-proceedings guaranteed Treaty Tribes 50% of harvestable salmon (Boldt decision) and shellfish resources (Rafeedie decision), and confirmed the value of habitat to maintain harvestable populations.

- Over a dozen species including fish, mammals, birds, and plants that are listed as endangered or threatened under the Endangered Species Act are dependent on the ecosystems of Puget Sound and either directly or indirectly on the Puget Sound nearshore zone.

The following sections describe the technical, institutional, and public significance of Puget Sound resources. Chapter 6 also includes expanded discussions of significance for each of the sites included in the recommended plan.

2.2.1 Technical Significance

The Nearshore Science Team (NST) consists of experts representing various technical disciplines to support and inform the Study in aspects of Puget Sound including biology, geology, and sociology. The NST has collaborated or authored several pivotal publications, which emphasize the technical significance of the Puget Sound including the following:

- Strategies for Nearshore Protection and Restoration in Puget Sound (Cereghino et al. 2012)
- Implications of Observed Anthropogenic Changes to the Nearshore Ecosystem in Puget Sound (Fresh et al. 2011)
- Historical Change and Impairment of Puget Sound Shoreline (Simenstad et al. 2011)
- A Geomorphic Classification of Puget Sound Shorelines (Shipman 2008)
- Valuing Puget Sound's Valued Ecosystem Components (Leschine and Petersen 2007)
- Conceptual Model for Assessing Restoration of Puget Sound Nearshore Ecosystems (Simenstad et al. 2006)

These peer-reviewed technical reports have informed local ecosystem restoration projects and local regulatory approaches.

2.2.2 Institutional Significance

Laws, adopted plans, and other policy statements of public agencies, tribes, or private groups all show institutional recognition of environmental significance. Following enactment of the ESA in 1973, the Federal Government began to address the decline of individual species with the listing

of endangered species and the subsequent development of recovery plans. As of 2016, 13 fish and marine mammal species in Puget Sound are listed under the ESA as threatened or endangered. The responsible agencies have developed or are working on recovery plans for eight of the listed species. State efforts to address the decline of Puget Sound have been underway for many years, focusing on addressing water pollution. In 2007, the Puget Sound Partnership (PSP) replaced previous water quality agencies, and began integrating the work of State, local, and Federal Government entities, as well as local watershed planning and salmon recovery efforts. The PSP created the Puget Sound Action Agenda in 2008 and works to revise the plan through research and many collaborative partnerships (PSP 2008, 2012). The Action Agenda serves as a statement of common purpose across Puget Sound and forms the basis for cooperation and collaboration among implementing partners. The Nearshore Study is the nearshore ecosystem component of PSP's set of actions identified to protect and restore Puget Sound.

The Nearshore Study is a critical aspect to the various mission areas and agency interests outlined below. The proposed actions in the Nearshore Study are integral to a comprehensive restoration effort of institutionally significant resources within Puget Sound. Specific examples of institutional recognition of the significance of the resources being addressed by this study include the following:

A. *Puget Sound Partnership (PSP)* - The State of Washington has invested in the health of Puget Sound by creating specific agencies including the former Puget Sound Action Team, since replaced by PSP. PSP has developed an Action Agenda that addresses restoration and protection of Puget Sound, and uses "indicators" and "recovery targets" to help measure success. These include habitat features such as estuaries, floodplains, and eelgrass, and species including birds, herring, killer whales, and salmon (PSP 2012).
B. *Environmental Protection Agency (EPA)* - Puget Sound has been designated an estuary of National Significance under §320 of the Clean Water Act. The goal of the Puget Sound National Estuary Program is to restore and maintain the Puget Sound Estuary's estuarine environment so that it will support balanced indigenous populations of shellfish, fish, and wildlife, and support the extensive list of recognized uses of Puget Sound. In 2009, the EPA adopted the PSP Action Agenda as the Comprehensive Conservation and Management Plan of the Puget Sound National Estuary Program.
C. *Council on Environmental Quality (CEQ)* - President Obama established the Interagency Ocean Policy Task Force in 2009 to develop recommendations to enhance the nation's ability to maintain healthy, resilient, and sustainable oceans, coasts, and Great Lakes resources (CEQ 2010b). The task force established a new National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes that set nine national priority objectives. The Nearshore Study aligns well with these objectives, especially the recommendation to "establish and implement an integrated ecosystem protection and restoration strategy that is science-based and aligns conservation and restoration goals at the Federal, State, tribal, local,

and regional levels." These recommendations target Puget Sound as one of the prioritized regions for restoration effort.

2.2.3 Public Significance

Public recognition of the significance of a resource may involve memberships in a conservation organization, financial contributions to resource-related efforts, volunteer labor, and correspondence regarding the importance of the resource. Public concerns with the health of the Puget Sound ecosystem have been evident for decades. As early as the 1920s, shellfish growers pointed to pollution from pulp mills as an issue, and in 1945 the State formed the Pollution Control Commission (The Olympian 2007). More recently, several large non-profit organizations have indicated interest in improving the ecosystem quality and function of the Puget Sound (e.g., Ducks Unlimited, Seattle Audubon Society, and The Nature Conservancy [TNC]). Reflecting the concerns of a range of people nearby, a large number of local groups have formed around improving conditions in the Puget Sound within the project area, including the following:

- Marine Resource Committees
- Regional Fisheries Enhancement Groups
- Orca Network
- Puget Sound Restoration Fund (Olympia Oysters)
- Pacific Coast Joint Venture
- Friends of the San Juans
- Puget Soundkeeper Alliance
- The Mountaineers
- Volunteers for Outdoor Washington
- Washington Council of Trout Unlimited
- Washington Water Trails Association
- Wild Fish Conservancy
- People for Puget Sound
- Washington Environmental Council

Public significance is further highlighted by the State of Washington's multi-million-dollar restoration budget, support from municipalities, NGOs, and other non-Federal partners in the cost-sharing of restoration efforts, as well as implementing millions of dollars' worth of generally smaller scale restoration work in Puget Sound without Corps involvement. These investments are important aspects of public significance of the resources within Puget Sound.

2.3 PROBLEMS AND OPPORTUNITIES

This section documents the identification of problems and opportunities in Puget Sound's nearshore zone, which is the first step in the Corps' six-step planning process (ER 1105-2-100; USACE 2000a). From the planning perspective, a problem can be thought of as an undesirable

condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. The problems identified in the Puget Sound nearshore area are listed here and discussed below.

- Degradation of large river deltas
- Loss of coastal embayments
- Disconnection between beaches and bluffs
- Loss of estuarine wetlands
- Shortening and simplification of the shoreline
- Accumulation of multiple stressors

The Nearshore Study identified "valued ecosystem components" (VECs) that share the three characteristics described in "Valuing Puget Sound's Valued Ecosystem Components" (Leschine and Petersen 2007). First, each is judged likely to be enhanced by nearshore zone restoration. Second, each VEC has direct or indirect value to humans socially, culturally, or environmentally. Third, many people recognize each component as emblematic of a "healthy" Puget Sound. The Nearshore Study identified the following nine VECs:

- Coastal forests (marine riparian vegetation)
- Beaches and bluffs
- Eelgrass and kelp
- Forage fish
- Juvenile salmon (including three ESA-listed species)
- Killer (orca) whales (ESA-listed)
- Native shellfish (includes one state candidate species)
- Great blue herons
- Nearshore birds

The problems described below affect these VECs directly or indirectly as detailed in a series of white papers available at *www.pugetsoundnearshore.org/technical_reports*. For example, forage fish rely directly on suitable beach habitat for spawning, and juvenile salmon rely directly on suitable delta habitat for rearing and on embayments for migration, while orcas benefit indirectly through increased availability of salmon as prey and through the water quality improvements that healthy deltas with abundant wetlands provide.

2.3.1 Sound-wide Problems

In their 2009 State of the Sound Report, the PSP's Science Panel evaluated ecosystem status indicators including human health, human well-being, species and food webs, habitats, water quantity, and water quality. The report concludes that "compared to historical conditions, the

Puget Sound ecosystem shows signs of stress and degradation from human activity." About half of the indicators in the report provide evidence of continuing decline in the Puget Sound ecosystem, while several other indicators show evidence of improving conditions. The remaining few indicators describe ecosystem aspects for which no clear trend was apparent. Declining indicators include three of the VECs that the Nearshore Study evaluated: killer whales, eelgrass, and forage fish (herring). Shellfish harvest shows signs of improvement, and Chinook salmon run size has slightly increased since their ESA listing in 1999; however, Chinook populations remain substantially below recovery targets (PSP 2009). In a subsequent report, the PSP adopted a set of 21 indicators for assessing Puget Sound health. Data on status and trends of these "vital signs" are under development. Many of these overlap with the VECs that the Nearshore Study identified, including Chinook salmon, killer whales, herring, birds, eelgrass, estuaries, and functioning beaches (without shoreline armoring) (PSP 2012).

2.3.2 Nearshore Ecosystem Problems

Impairment of nearshore processes and degradation of ecosystem functions are critical factors in the declining health of Puget Sound. The alterations to the physiographic processes of the nearshore zone directly and indirectly affect the ecosystem functions upon which humans depend. Watersheds comprising a mere 0.2% of the Puget Sound shoreline length and 0.003% of the Puget Sound watershed area have not encountered any degradation of nearshore ecosystem processes (Schlenger et al. 2011a). The problems of the other 99.8% of the shoreline and 99.997% of the watershed area are summarized in this section. The problems described below directly affect many plants and animals in Puget Sound and the ecosystem as a whole. Sections 2.3.2.1 through 2.3.2.6 below are excerpted from Fresh et al. (2011).

2.3.2.1 *Effects to Large River Deltas*

Barriers to tidal hydrology have affected large river deltas.

2.3.2.1.1 *Physical Changes*

All of the 16 largest deltas of Puget Sound have been extensively modified. Combining all 16 deltas, the total length of their shoreline has decreased by 109 miles or 26.6% from historical conditions. The two primary anthropogenic stressors in large deltas are tidal barriers, which account for nearly 200 miles of the current delta shoreline, and armoring, which accounts for 108 miles of the current delta shoreline. Changes to the wetlands of the large deltas have been especially dramatic. In aggregate, 55.5% of the historical wetlands (57,823 acres) in the 16 largest deltas of Puget Sound have been eliminated (Simenstad et al. 2011).

Watershed changes can affect deltas in ways that were not directly detected in the Change Analysis. For instance, water diversions can alter the equilibrium between sediment transport to deltas and sediment transport within them. Half of the watersheds associated with the large deltas of Puget Sound have at least one significant water diversion. In one case, Jay and Simenstad

(1996) suggested that the effects of a 40% reduction in the average annual discharge of the Skokomish River due to a hydropower diversion could be responsible for a 15 to 19% loss of low intertidal area and a 17% loss of sub tidal eelgrass on the outer delta.

Bolte and Vache (2010) project that by the year 2060, population growth will introduce development and stressors to five of the six large river deltas that do not yet have significant development at their mouths; the forecast for all 16 large river deltas represents an overall loss of 59% of historical tidal wetlands. In addition to wetlands protection under the Corps' regulatory program, Executive Order 11990 dictates no net loss of wetland functions and values; however, Corps enforcement of this policy when unauthorized fill occurs is discretionary. The wetland-fill permitting process may prevent a net loss of total wetland area, but mitigation measures may cause the type and location of wetlands to shift toward wetland banks and areas protected from development, and away from desirable nearshore zone development locations such as private waterfront properties. Furthermore, mitigation ratios are intended to account for potential loss of in-kind functions and temporal impacts, but there are risks and uncertainties that may hamper the success of mitigation projects, and monitoring is not always performed consistently enough or long enough to ensure full replacement of functions and values.

2.3.2.1.2 *Implications*

One significant implication of changes to deltas is that much less native habitat is available for plants and animals. In particular, diking and filling of deltas have eliminated most of the channels that historically cut through deltas and have thus restricted fish and wildlife to smaller areas. River deltas that have been simplified to a single channel, such as the Puyallup and Duwamish, which are now the Port of Tacoma and the Port of Seattle, respectively, concentrate fish into a smaller area thereby limiting their ability to avoid predators or stressful environmental conditions and significantly reducing the overall habitat carrying capacity. Loss of delta area has affected the quantity and quality of habitats available for birds for feeding, roosting, and reproduction. At least 30 species of shorebirds use estuarine tide flats associated with Puget Sound's deltas (Buchanan 2006).

The loss of tidal prism (volume of water exchanged by tides) can have ramifications to the local flooding regime by increasing freshwater flood peaks. In addition, tidal prism loss can cause the simplification and loss of volume of tidal channel networks outside the area enclosed by tidal barriers (Hood 2004). The loss of tidal prism in the delta and the addition of dams and diversions within the watershed can alter estuarine salinity structure, shifting the area and location of wetland types sensitive to certain salinity regimes.

2.3.2.2 *Disconnection or Loss of Coastal Embayments*

Small coastal embayments have been eliminated throughout Puget Sound or had their connections to the Sound severed.

2.3.2.2.1 *Physical Changes*

Puget Sound has experienced a significant loss in the numbers of small, coastal embayment landforms. Overall, 884 historical (1850s-1890s) embayment landforms were mapped, and 579 were mapped in current conditions (2006) representing a loss of 305 embayments (Simenstad et al. 2011).

Embayments historically accounted for 689 miles of Puget Sound shoreline (23.2%) but now account for 375 miles of shoreline (15.0%); this represents a decline in length of 45.5%. Historically and currently, the embayment landform type that represents the greatest proportion of Puget Sound's shoreline is the open coastal inlet. Of the embayments that remain along Puget Sound, many have been extensively modified. Armoring is the main modification, with 18% of the shoreline length of embayments armored. Changes to embayments vary considerably among the seven sub-basins (see section 1.2 for sub-basins).

Based on land cover projections from Bolte and Vache (2010), losses of tidal wetlands are expected to continue. They project these losses to occur in embayments and large river deltas. Modeling the effects of increased regional population and associated development leads to a projected loss of 17%, or 1,013 acres, of the current extent of tidal wetlands by 2060. This forecast represents an overall loss of 75% of historical tidal wetlands in embayments. Mitigation required through wetland-fill permitting could create new wetlands in other locations such as wetland banks to maintain no net loss; however, wetlands upstream from the nearshore zone have different benefits than the marine and estuarine types with their associated species assemblages.

2.3.2.2.2 *Implications*

The sheltered condition of embayments makes them important habitat for native shellfish, fish, and shorebirds. For example, embayments can provide a sheltered, food-rich environment for several species of juvenile fish during certain times of the year. Recent evidence from the Whidbey Sub-basin shows that large numbers of post-larval and juvenile surf smelt rear in some of the "pocket estuaries" found there (Beamer et al. 2006). In addition, during late winter and early spring, large numbers of juvenile Chinook and chum salmon rear in pocket estuaries of the Whidbey Sub-basin. The juvenile Chinook salmon are part of federally protected populations and are considered to be one of the life history types that support viability of the species (Beamer et al. 2005).

2.3.2.3 *Disconnection or Loss of Beaches and Bluffs*

Changes to beaches and bluffs have resulted in the loss of sediment supply and the interruption of sediment transport processes.

2.3.2.3.1 *Physical Changes*

As with other Puget Sound landforms, the amount of beach shoreline has declined from historical conditions, but the magnitude of changes was less pronounced than for embayments and large deltas. Historically, 38.5% of Puget Sound's shoreline (950 miles) was composed of bluff-backed beach; it was (and remains) the dominant landform in Puget Sound. Barrier beaches (i.e. depositional features that form across bays or small estuaries) were the fourth dominant landform, accounting for 273 miles (11.1%) of the shoreline. From historical to current conditions, bluff-backed beach and barrier beach length declined by 80 miles and 37 miles, respectively. Changes to beaches varied greatly between sub-basins (Simenstad et al. 2011).

Puget Sound beaches have seen many modifications. Armoring (seawalls and revetments) is the most pervasive direct alteration. Armoring occurs along 33.4% of bluff-backed beaches and 27.2% of barrier beaches; 34.0% of all bluff-backed beaches are armored along more than half of their length. Only 25.0% of all bluff-backed beaches are completely unarmored. The distribution of armoring associated with beaches varies greatly among sub-basins. Other than armoring, roads and nearshore fill are the most significant stressors affecting beaches in Puget Sound. For example, roads and nearshore fill each affect about 10% of the length of bluff-backed beaches.

2.3.2.3.2 *Implications*

One of the most important physical processes occurring along beaches and bluffs is the erosion, transport, and distribution of sediment. Sediment processes are dynamic and driven by storms, wave action, and tides. They vary significantly along shore and from one part of Puget Sound to another, due to variability in wave action, geology, and the shape of the inherited glacial landscape (Finlayson 2006). Sediment processes, in combination with other factors, such as disturbance regimes, directly affect characteristics of beaches fed by those sediments and the composition, abundance, and diversity of plant and animal communities associated with them (Turner et al. 1995; Farina 2000).

Disruption of sediment processes can result from anthropogenic stressors such as structures placed either along (parallel to) or across (perpendicular to) the shoreline, which can affect the amount and size (grain size) of sediment delivered to the beach, and how and where it is transported. One of the most apparent human-caused changes to a beach is placement of structures (e.g. nearshore fill or armoring) parallel to the shore that cuts off or isolates bluffs that are sediment sources (so-called feeder bluffs) (Shipman et al. 2010). This is because the primary source of sediment to the non-delta landforms of Puget Sound is the feeder bluffs associated with bluff-backed beaches. Downing (1983) estimated that erosion of coastal bluffs supplies 90% of the sediment to Puget Sound beaches, and shoreline armoring occurs along approximately 33% of those bluffs (Schlenger et al. 2011a). Disruptions in sediment processes can change the physical characteristics of a beach, including changes in sediment composition (e.g., coarsening

of the material), beach slope, and beach width (Pilkey and Wright 1988; Shipman et al. 2010). Down-drift beaches in the vicinity can disappear, and beach width can decline (Griggs 2005).

Various biological effects can result from changes in sediment processes including changes in invertebrate communities, loss of forage fish spawning habitat, and loss of feeding and migration habitat for juvenile salmon and forage fish (Shipman et al. 2010). Armoring can affect benthic and epibenthic invertebrates due to a loss of beach area, changes in beach slope, and changes in substrate characteristics. Because the composition of intertidal invertebrate communities is strongly linked to substrate characteristics (Dethier and Schoch 2005), changes in local sediment characteristics due to armoring (e.g., caused by wave reflection or blocked sediment sources) can alter the abundance and composition of infaunal and epifaunal organisms, including shellfish.

Armoring can affect reproduction of forage fish in several ways. First, armoring low in the intertidal zone can displace the spawning habitat of several species (e.g. surf smelt and sand lance) that spawn on fine-grained substrates on the upper beach (Penttila 2007). Second, by blocking sediment input to the beach, armoring can cause spawning areas to convert from the fine-grained material that the fish need for spawning to coarser materials such as gravel and cobble that are unsuitable for spawning. Third, armoring can negatively affect forage fish populations by increasing sediment temperatures on the upper beach, where shading by natural shoreline vegetation has been removed; this reduces survival of incubating embryos (Rice 2006). In addition to effects on reproduction of forage fish, armoring can affect feeding behavior of juvenile forage fish (as well as juvenile Pacific salmon) that often feed in shallow water at high tide. When shoreline modifications extend lower on the shore, the truncation of intertidal shallow water habitat by armoring reduces foraging by juvenile fish on riparian insects (Toft et al. 2007).

Projected sea-level change and increased storm frequency and magnitude are expected to cause the base of the coastal bluffs along bluff-backed beaches to be more frequently inundated by waves. This increased wave action on the base of the bluffs is expected to cause additional bluff erosion and increase sediment inputs to the nearshore zone. It is expected, however, that shoreline property owners may respond by constructing additional armoring to reduce bluff-backed beach erosion. Expected increases in shoreline armoring related to sea-level change are unquantified and are not included in the Bolte and Vache (2010) projections.

2.3.2.4 *Loss of Estuarine Wetlands*

Extensive losses of tidal/estuarine wetlands have occurred throughout Puget Sound. There are four types of tidal/estuarine wetlands: euryhaline (i.e. high saltwater concentration) unvegetated, estuarine mixing, oligohaline transition, and tidal freshwater.

2.3.2.4.1 *Physical Changes*

Puget Sound has experienced a dramatic loss of tidal/estuarine wetlands. Most Puget Sound tidal/estuarine wetlands are associated with the 16 large deltas. These delta systems historically

contained nearly 103,000 acres of tidal/estuarine wetlands (all four types combined), compared to the current 45,220 acres, a decline of 56%. For landforms other than large deltas (mostly embayments), the estimated 25,205 acres of historical wetlands has declined to 8,229 acres, a loss of 69% (because data on the amount of euryhaline unvegetated wetland is only reliable for the large deltas, the estimated 25,205 acres of historical wetlands does not include that type).

Considering just the estuarine mixing, oligohaline transition, and tidal freshwater (i.e. vegetated) tidal/estuarine wetland types, 74.2% of wetlands that historically surrounded the shores of Puget Sound have been lost. Tidal freshwater and oligohaline transitional wetlands have been nearly eliminated. Combining all landforms, 93.1% of these two wetland types have been lost throughout Puget Sound. Of the 15,815 acres of historical oligohaline transition marsh, only 371 acres remain. The loss of tidal wetlands has been especially dramatic in several sub-basins and in several large deltas in particular. In the Duwamish and Puyallup river deltas, almost no wetlands remain of any type as these deltas have been developed into the Port of Seattle and Port of Tacoma, respectively. In the Whidbey Basin, the amount of oligohaline transition and tidal freshwater wetlands declined from 14,826 acres to 148 acres and from 21,745 acres to 2,224 acres, respectively. Most of this loss was in the three large deltas found in this sub-basin.

Based on land cover projections from Bolte and Vache (2010), losses of tidal wetlands are expected to continue. These losses are projected to occur in embayments and large river deltas. In addition to previously cited projected future losses of coastal embayment wetlands, (17%), large river deltas are projected to lose 3% (1,606 acres) of their current extent of tidal wetlands between now and the year 2060. While new wetlands can be created through the permitting process to prevent a net loss of total wetland area, the use of mitigation banking is rare in estuarine areas, so mitigation may cause a shift in wetland types from estuarine to other types.

The projected increases in armoring paired with the projected sea-level change will likely cause further wetland losses beyond those projected by Bolte and Vache (2010). Some of the current tidal wetlands occur at elevations that will be inundated too deeply and/or too frequently as the sea-level changes. In a natural setting, many of these wetlands might shift to colonize higher elevations that would provide suitable conditions; however, the presence of barriers to tidal inundation (e.g., armoring) will limit the ability of estuarine wetlands to migrate landward.

2.3.2.4.2 *Implications*

Wetlands are one of the most important ecosystem types, wherever they occur, because they provide a wide variety of functions, including primary production; nutrient cycling; biophysical mediation of contaminants; fish and wildlife habitat, particularly for reproduction and feeding; and support of coastal fisheries species (Boesch and Turner 1984; Mitsch and Gosselink 2007).

Throughout the Pacific Northwest, one of the most prominent functions of estuarine wetlands, especially those associated with large deltas, is that they support extended rearing of several

species of juvenile salmon (Healey 1982; Levy and Northcote 1982; Simenstad et al. 1982; Bottom et al. 2005a, 2005b; Henning et al. 2006). Studies have demonstrated that particular "life history types" are those that use delta wetland habitats for extended periods and depend on this habitat for initial, early growth (Fresh 2006). The production of these life history types is important to maintaining population resilience and supporting efforts to rebuild salmon populations (Bottom et al. 2005a). Because there is a strong relationship between juvenile salmon size and their survival to the next life phase (Duffy 2009), high growth rates in juvenile salmon during their residency in estuarine areas are critical to the survival of these life history types and their contribution to population resilience.

2.3.2.5 *Shortening and Simplification of Shoreline*

The shoreline has become shorter, simpler, and more artificial.

2.3.2.5.1 *Physical Changes*

In addition to the types of structural changes (i.e., stressors) described previously (e.g., construction of bulkheads, roads, and overwater structures), the basic character of the shoreline has changed. In particular, the shoreline of Puget Sound has become shorter and simpler over the past 150 years. Over all of Puget Sound, the net loss of shoreline length has been 431 miles, meaning the current shoreline is about 15% shorter than the historical length of the shoreline, as shown in Figure 1-5. While more than 600 miles of natural shoreline was eliminated, 229 miles of artificial shoreline was added (herein, artificial means human-made landforms such as seawalls backed by fill). Although the length of shoreline classified as artificial was negligible historically, artificial shoreline now represents about 9.5% of the length of shoreline in Puget Sound. There was a strong association between fill placed in the nearshore zone and the artificial landform type, with fill occurring along 62% of the length of artificial landforms.

Although available land cover projections from Bolte and Vache (2010) do not provide estimates of shortening and simplification of the shoreline, it is anticipated that the projected addition of nearly 100 miles of shoreline armoring between now and 2060 will continue a long trend of shortening and simplifying the shoreline through development. In those areas where armoring is added, the shoreline loses its natural complexity and heterogeneity; in those areas, the shoreline will be converted from a mix of landforms and habitats to straightened and simplified reaches within which the connection between terrestrial and aquatic habitats and resources is interrupted.

2.3.2.5.2 *Implications*

Although some of the changes in shoreline length and in landform were clearly due to natural processes such as erosion, waves, and floods, many are due to anthropogenic influences. The simplification and shortening of Puget Sound's shoreline has altered the fundamental way that nearshore ecosystems function. The way an ecosystem works depends in part upon characteristics of surrounding ecosystems and the spatial arrangement of their components, sizes,

shape, and location (Forman and Godron 1986; Turner 1989; Fahrig and Merriam 1994; Bell et al. 1997; Wiens 2002; Bilkovic and Roggero 2008; Partyka and Peterson 2008). Simply by changing how Puget Sound's parts are arranged, people have changed how water and sediment move around, where and how much sediment is deposited, and how detritus and nutrients are processed and cycled (Farina 2000; Lourie and Vincent 2004). Furthermore, people have modified the behavior and survival of species and altered the composition of plant and animal communities (Bell et al. 1997; Farina 2000; Wiens et al. 2002; Lourie and Vincent 2004).

Changes to shoreline complexity and the loss of shoreline length have affected the rate, magnitude, and effectiveness of many ecosystem processes that depend on the amount of space available. The loss of shoreline length has reduced the amount of space in Puget Sound for fish and wildlife to reproduce, feed, and grow (Dethier 2006; Coen et al. 2007). In particular, juvenile salmon, which are closely associated with nearshore ecosystems during their migration to the ocean, now have less space to feed, grow, and evade predators; such impacts have reduced their survival (Beamer and Larsen 2004). The loss in shoreline length has likely affected other habitats as well, such as eelgrass beds, although historical data is insufficient to quantify this change.

2.3.2.6 *Cumulative Effects of Multiple Stressors*

Many nearshore places have experienced multiple types of stressors (cumulative effects).

2.3.2.6.1 *Physical Changes*

Many of the altered shoreline segments around Puget Sound have not just one, but multiple types of human-caused alterations. Of the 812 shoreline segments (not including deltas) in Puget Sound, only 112 (14%) have no shoreline stressor (e.g., a dock, a marina, armoring, or fill). Segments with only one stressor make up 5% of the count, and 60% of shoreline segments have two to four stressors. Although no shoreline segments contain all nine stressors, 81% of segments have more than one type of stressor, suggesting a high potential for cumulative effects. Of the nine shoreline stressors considered in the Nearshore Study, armoring is clearly the dominant stressor, occurring in 78% of all shoreline segments. When calculating length of changes rather than number of segments, armoring occurs along 27% of the shoreline of Puget Sound. Other stressors often co-occur with armoring. Of the 2,466 miles of shoreline in Puget Sound, 23% of the length has one stressor, 12% has two stressors, and 6% has three or more.

2.3.2.6.2 *Implications*

It is highly likely that cumulative effects are negatively affecting nearshore ecosystem functions. Cumulative effects refer to the combined, incremental effects of human activities on the environment (EPA 1999). Cumulative effects may be synergistic, in that the overall effect is more than the sum of the individual effects (Williams and Faber 2001; Peterson and Lowe 2009). While a small-scale alteration may be insignificant (and not even noticed) by itself, cumulative effects from one or more sources often accumulate over time and space (Jordan et al. 2008;

Peterson and Lowe 2009). Such changes to ecosystems are usually small-scale and can occur through persistent additions or losses of the same resources and through the compounding effects of two or more stressors (Reeves et al. 1993; May 1996). In the nearshore ecosystems of Puget Sound, cumulative effects include not only the physical changes upon which the Nearshore Study has focused, but other effects as well, such as changes to water and sediment quality.

2.3.3 Opportunities

Opportunities exist to address problems in Puget Sound nearshore ecosystems and thereby contribute to the health of species that depend on that habitat, directly or indirectly, for survival.

2.3.3.1 *Restoration Opportunities*

Puget Sound deltas have opportunities to increase the quantity and quality of valuable habitat for a variety of fish, wildlife, and plants. For example, restoration of estuarine habitat would benefit salmonids that depend on such habitat as they transition from freshwater to saltwater and back. Restored estuarine wetlands would benefit over 30 species of shorebirds found in Puget Sound deltas. There are opportunities to improve the overall water quality of Puget Sound through restoring some of the deltas that have historically provided that function.

At degraded coastal embayments around Puget Sound, opportunities exist to improve conditions for native shellfish, fish, and shorebirds. In particular, there are opportunities to benefit juvenile Chinook salmon populations that depend on the protected nature of coastal embayments for rearing habitat, and there are opportunities to improve conditions for surf smelt, a forage fish species that is an important part of the diet of Chinook salmon. There are also opportunities to restore degraded wetlands associated with coastal embayments, re-establishing diminished habitat, and contributing to improved water quality in Puget Sound.

Through restoration of beaches and the bluffs that provide the sediment that beaches depend on, there are opportunities to improve conditions for the fish and wildlife that inhabit or use Puget Sound beaches; and to contribute to the sustainability of barrier embayments that are made up of accreted sediment from eroding bluffs, providing habitat for migrating salmonids, native shellfish, and shorebirds. Such restoration represents opportunities to improve conditions for organisms at many levels of the food chain, including invertebrates, forage fish, and salmonids.

An additional consideration for restoration is the potential for sea level change. Although it is often seen as a limiting condition, it can also be viewed as an opportunity to enact managed retreat from altered coastal conditions. In the situation where it is not feasible to preserve historic infrastructure while restoring habitat under conditions of sea level change, artificial shorelines may be restored to natural function by removal of the threatened structures.

In summary, through addressing the problems observed in Puget Sound's deltas, embayments, beaches, and bluffs, there are opportunities to restore some of the historic structural complexity

to the shoreline, increasing the area available for habitat as well as the diversity of ecological niches required to support Puget Sound's rich natural heritage.

2.3.3.2 *Protection Opportunities*

A critical part of a comprehensive approach to ecosystem recovery is to protect healthy, functioning portions of the nearshore zone. Considering that restoration often requires protecting lands, and full function of restored lands may be delayed while systems reestablish, protection is often a more cost-effective approach to ensuring delivery of ecosystem functions. The Strategies Report (Cereghino et al. 2012) identifies intact sites with high potential for protection; however, because protection is not a Corps mission, it is not included in the planning objectives for this study. However, because the Corps restoration mission is to implement and restore where the Corps expertise is needed to restore function and quality, acquisition for protection is not a planning objective.

2.3.3.3 *Learning Opportunities*

Restoration efforts offer opportunities for further learning, research, and education. Specifically, learning opportunities include the following:

- Increased institutional capability and capacity will arise as ecosystem restoration provides a setting for learning.
- Improvement in the performance of projects will provide feedback that can help reduce the uncertainty in implementing new projects and in applying adaptive management measures to constructed projects.

2.4 PLANNING OBJECTIVES

The Study team developed three broad planning objectives with associated sub-objectives to guide the formulation of alternative plans aimed at addressing the problems and opportunities described in section 2.3. The planning objectives articulate the Study's goal to restore the physiographic processes that sustain the Puget Sound nearshore ecosystem and its broad array of nationally and regionally significant resources. Through process restoration, the project aims to sustainably address impairment to the nearshore zone's ability to deliver ecosystem structures, functions, and processes, and to support valued ecosystem components. The planning objectives appear in Table 2-1, along with associated problems, opportunities, and affected species. Chapter 6 includes site-specific planning objectives for the sites included in the recommended plan.

In the following sections, each planning objective is briefly described along with sub-objectives that more fully detail the planning objective's intent. Sub-objectives refer to removal of stressors that impact physiographic processes that sustain the nearshore ecosystem; in all cases the Nearshore Study's intent is to remove all stressors within the footprint of a given restoration site, except where constraints limit that goal. The degree to which proposed solutions achieve objectives was calculated by the ecosystem output model developed for the Nearshore Study.

Table 2-1. Planning Objectives

Planning Objectives[1]	Sub-objectives	Problems	Representative Species Affected
1. Restore connectivity and size of large river delta estuaries in the Puget Sound Nearshore for the 50-year period of analysis.	Restore tidal flow and inundation area in river deltas Restore quality and quantity of tidal wetlands in river deltas with emphasis on oligohaline and tidal freshwater wetlands Improve connectivity between the nearshore zone and adjacent uplands/ watershed Increase the shoreline length of large river deltas	• Large River Delta Impacts • Estuarine Wetland Loss • Shortening and Simplification of Shoreline Multiple Stressors	• Puget Sound Chinook salmon and other salmonids Great blue herons Peregrine falcons • Shorebirds (>30 species) Killer whales
2. Restore the number and quality of coastal embayments in the Puget Sound Nearshore for the 50-year period of analysis.	Restore embayment shoreline length that has been reduced through fill placement Restore embayments that have transitioned to an artificial landform or have been lost through conversion to uplands Restore degraded embayments Restore quality and quantity of tidal wetlands in coastal embayments	• Coastal Embayment Loss or Disconnection • Estuarine Wetland Loss • Shortening and Simplification of Shoreline Multiple Stressors	• Puget Sound Chinook salmon and other salmonids Shellfish Olympia oysters Forage fish Kelp and Eelgrass
3. Restore the size and quality of beaches in the Puget Sound Nearshore for the 50-year period of analysis.	Restore sediment input processes at bluff-backed beaches in divergence zones and transport zones of sediment drift cells Improve sediment transport and accretion processes by removing sub tidal and intertidal stressors contributing to shoreline degradation	• Beaches and Bluffs Disconnection Multiple Stressors • Shortening and Simplification of Shoreline	• Puget Sound Chinook salmon and other salmonids Forage fish Shellfish Olympia oysters

Notes: 1. All objectives cover the 50-year period of analysis.

2.4.1 Objective 1 – Restore Connectivity and Size of Large River Deltas

The 16 large river deltas distributed throughout Puget Sound vitally contribute to the overall health of Puget Sound ecosystems. These delta areas support a broad set of nearshore ecosystem processes in different ways than shoreline areas, and their contributions extend far beyond their delineated boundaries. Opportunities to restore processes should be identified and developed in areas with consideration for restoring "stepping stones of healthy patches" to increase landscape connectivity, as described in Principles for Strategic Conservation and Restoration (Greiner 2010). This objective has the following four sub-objectives:

- Restore tidal flow in river deltas
- Restore wetland quality and quantity with emphasis on oligohaline and tidal freshwater
- Improve connectivity between the nearshore zone and adjacent uplands/watershed
- Increase the shoreline length of large river deltas
- Increase riparian areas in river deltas

2.4.2 Objective 2 - Restore the Number and Quality of Coastal Embayments

Embayments are significant landscape features that contribute to the complexity and heterogeneity of the Puget Sound shoreline. Embayments between the large deltas and in areas where deltas are absent provide important habitats for a variety of valued species including several species of salmon, more than 30 species of shorebirds, and migratory waterfowl. Many of the remaining embayments have been reduced in size, complexity, and function through stressors such as fill, armoring, stream crossings, roads, and railroads. Restoration can recover the historical footprint (size and shape) and associated functions of the embayment. Embayments can also be restored at sites where, due to fill and other stressors, they no longer exist. This objective is broken into the following four sub-objectives:

- Restore shoreline length reduced through fill placement and other stressors
- Restore embayments that have transitioned to artificial or have been lost
- Restore degraded embayments
- Restore quality and quantity of tidal wetlands in coastal embayments

2.4.3 Objective 3 – Restore the Size and Quality of Beaches

The nearshore ecosystem processes of sediment input, transport, and accretion are vital to supporting many of the unique and important characteristics of Puget Sound, such as shallow beach slopes, woody debris and algae accumulation, migration corridors for wildlife, beach spits, and other habitat features critical to the survival of Puget Sound biota. Results of historical change analysis indicate that there is a widespread need for the restoration of these processes of sediment movement throughout Puget Sound. While restored sediment supply at the site of an historic bluff-backed beach will support the reestablishment of the intertidal habitat, the benefits of restoring processes extend far beyond the site of restoration. Reconnecting a sediment source to the intertidal area at the up drift end of a non-degraded longshore sediment drift cell can contribute to maintenance of barrier beaches miles down drift. The following two sub-objectives are included in this objective:

- Restore sediment input processes by reducing degradation of bluff-backed beaches in divergence zones and transport zones of sediment drift cells
- Improve sediment transport and accretion processes by removing sub tidal and intertidal stressors contributing to shoreline degradation

2.5 PLANNING CONSTRAINTS

Unlike planning objectives, which represent desired positive changes, planning constraints represent restrictions. A planning constraint is any technical, legal, departmental, or operational restriction that limits the extent of the planning process or scope.

The planning constraints identified in this study are as follows:

- No restoration action will be considered in locations with known hazardous, toxic, and radioactive waste (HTRW) issues; all known HTRW sites will be avoided.
- The restoration plan should not induce flooding of existing structures to the maximum extent practical.
- The restoration actions should not impact transportation infrastructure that directly supports life safety or economic viability.
- International boundaries constrain project opportunities. Puget Sound, as defined for this study, is the U.S. portion of the larger Salish Sea that extends into Canada. The study area is limited to Puget Sound, and does not include Canadian portions of the Salish Sea.
- The recommended set of restoration actions should be sized so as to expect them to be funded and implemented within the next 10 to 20 years.
- The development of restoration projects should be sensitive to the Corps Trust responsibilities to Federally recognized Tribes and when sited, should not negatively impact Tribal resources. Tribal resources may include but are not limited to: Usual and Accustomed (U&A) treaty reserved fishing, hunting, and gathering areas within the project area.

Chapter 6 also includes site-specific planning constraints for the sites included in the recommended plan.

3 AFFECTED ENVIRONMENT*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

This chapter describes the existing conditions and future without-project conditions used for analysis. Existing conditions are the physical, chemical, biological, and sociological characteristics of the study area, which is the Puget Sound nearshore zone as defined in Figure 1-2 and covering all seven sub-basins as identified in section 1.3. Characterizing resource conditions is critical for estimating their future condition (the without-project condition) and for defining problems and opportunities. Scoping required by NEPA was introduced in section 1.9; all related activities appear in section 8.3.6. During the scoping process, agencies and the public identified topics of interest for analysis. Resources that would be affected by proposed actions are described here and project effects are analyzed in Chapter 5. Other resources, as described in section 3.5, did not receive a detailed analysis because the agencies determined the project would not have significant effects on these resources, and the public did not raise concerns. This chapter serves as a baseline of without-project conditions for analyzing the effects of different alternatives framed around the analysis of ecosystem processes, structures, and functions.

3.1 PHYSICAL ENVIRONMENT: NEARSHORE PROCESSES AND STRUCTURES

As discussed in section 1.8, the linkages between nearshore ecosystem processes, structures, and functions provide the analytical framework of the Nearshore Study. This framework derives from the hypothesis that "alterations of natural hydrologic, geomorphologic, and ecological processes impair important nearshore ecosystem structures and functions" (Simenstad et al. 2006). These relationships are important because ecosystem structure, a fundamental component of habitat, sustains socially relevant functions, including support for fish, wildlife, and plants, which in turn provide ecosystem functions in a dynamic relationship.

3.1.1 Nearshore Ecosystem Processes

Ecosystem processes are interactions among physical, chemical, and biological attributes of an ecosystem that cause change in character of the ecosystem and its components. The nearshore ecosystem processes that influence the marine and estuarine shorelines of Puget Sound occur and vary over diverse spatial and temporal scales. The processes are classified into three scales of influence on nearshore ecosystems: regional influences, broad physiographic processes, and local geochemical and ecological processes. *Regional influences* include factors such as climate, wave exposure, geology, inherited physiography, sea-level history, and tidal regime. The *broad physiographic processes* are considered landscape-forming processes, and are embedded within regional influences but vary considerably on scales of kilometers or smaller. Examples include sediment input to beaches and distributary channel formation. The *local geochemical and ecological processes* that occur within a given landscape structure, and vary within the local

structure of nearshore ecosystems, are shaped by the combined effects of the regional influences and broad physiographic processes. They vary on the order of meters within the local structures and, thus, are spatially and temporally complex. Examples include geochemical reactions that lead to nutrient cycling, primary production of plants, and food web interactions. The Nearshore Study assessment of ecosystem conditions focuses on the broad physiographic processes because they are responsible for creation and maintenance of the different complexes of landforms that characterize Puget Sound's shorelines. Eleven broad physiographic processes have been identified as most essential to the creation, maintenance, and function of Puget Sound's shoreline ecosystems; they are listed in Table 3-1.

Table 3-1. Nearshore Ecosystem Processes

Nearshore Ecosystem Process	Process Description
Sediment Input	Flux of sediments from bluff, stream, river, and marine sources Depending on landscape setting, scale can vary from acute, low frequency (hill slope mass wasting from bluffs) to chronic, high frequency (some streams and rivers)
Sediment Transport	Bed load and suspended sediment transport of sediments and other matter by water and wind along (long shore) and across (cross-shore) the shoreline as well as riverine transport in estuaries.
Erosion and Accretion of Sediments	Erosion (coastal retreat) of coastal bluffs, shorelines and estuarine river banks Deposition (dune formation, delta building, spits, and bars) of non-suspended (e.g., bed load) sediments and mineral particulate material by water, wind, and other forces Settling (accretion) of suspended sediments and organic matter on intertidal surfaces
Tidal Flow	Localized tidal effects on water elevation and currents, differing significantly from regional tidal regime mostly in tidal freshwater and estuarine ecosystems
Distributary Channel Migration	Change of distributary channel form and location caused by combined freshwater and tidal flow
Tidal Channel Formation and Maintenance	Geomorphic processes, primarily tidally driven, that form and maintain tidal channel geometry Natural levee formation
Freshwater Input	Freshwater inflow from surface (stream flow) and groundwater (seepage)
Detritus Import and Export	Import and deposition of particulate (dead) organic matter Soil formation Recruitment, disturbance, and export of large wood
Exchange of Aquatic Organisms	Organism transport and movement driven predominantly by water (tidal, fluvial) movement
Physical Disturbance	Change of shoreline shape or character caused by exposure to local wind, wave energy, and currents Localized disturbance such as large wood movement, scour, and over wash
Solar Incidence	Exposure, absorption, and reflectance of solar radiation and resulting effects

3.1.2 Geologic and Physiographic Setting

Puget Sound's striking terrain is a complex mixture of beaches, bluffs, deltas, mudflats, rocky archipelagos, and wetlands. Extensive glacial and tectonic activities caused many of the geomorphological features that characterize Puget Sound's shoreline. Other geologic processes, including weathering, erosion, and sedimentation, have further defined landforms and physical characteristics of the Puget Sound basin. At the peak of the Pleistocene epoch, a one-mile thick sheet of glacial ice covered the region and reached the southern extent of Puget Sound. The repeated advance and retreat of glaciers over many ice ages carved Puget Sound into its present form and reworked the till deposits. The region's soils are characterized as immature, being less than 10,000 years old. As is typical of fjords, water depths in Puget Sound increase rapidly from shore, with an average depth of 200 feet and a maximum depth of more than 1,200 feet.

Erosion, weathering, and alluvial deposition processes since retreat of the last glaciers have contributed to the mix of substrates of Puget Sound's nearshore zone. Studies show tremendous variability in substrate grain size along the shoreline. Puget Sound beaches have mixed sand and gravel sediments derived primarily from glacial till and outwash material that eroded from coastal bluffs (Downing 1983, Finlayson 2006). Sandy and muddy sediments from fluvial sources make up the large river deltas. The complexity and variability in Puget Sound shoreline substrates is mirrored in the geomorphology, diversity of the biota of the nearshore zone, and ecosystem functions provided. These relationships between process, structure, and function and the resulting biodiversity are the primary reasons the Nearshore Study chose to focus on restoration of the natural processes that supply and transport natural sediment sources.

The structures and habitats of Puget Sound are a complex mosaic of beaches and bluffs, estuaries, lagoons, river deltas, and rocky coastlines. Shipman (2008) defines a classification of Puget Sound nearshore landforms that reflects the primary role of geomorphic processes in shaping the landscape. This classification system identifies four geomorphic systems (structures) that form the foundation of this shoreline classification. Three of these systems (beaches, embayments, and river deltas) reflect differences in the roles of waves, tides, and rivers in transporting sediment and shaping the coastline. The most common Puget Sound shoreline type consists of mixed sand and gravel beaches backed by high coastal bluffs. Other sediment-dominated shoreline environments include large river deltas, tidal flats, salt marshes, and estuaries. A fourth system, rocky coasts, has limited availability of mobile sediment and a lack of major depositional landforms. Rocky-bottom habitat is less common than soft-bottom habitat and is confined mostly to northern Puget Sound.

Within each of these geomorphic systems, there can be a variety of smaller landforms. These can be complex features, their configuration determined by the shoreline, availability of sediment, and local influence of waves, tides, and stream-related processes. Figure 3-1 shows typical shapes and relationships of landform types. Table 3-2 summarizes the geomorphic systems and natural landforms described in detail by Shipman (2008). In addition to the natural landform

types defined by this classification system, the Nearshore Study mapped "artificial" areas, which are areas that have been fundamentally altered by dredging and filling. Artificial landforms often support biotic communities not present in natural shorelines. Approximately 240 miles (10%) of the shoreline in the study area is classified as artificial (Simenstad et al. 2011).

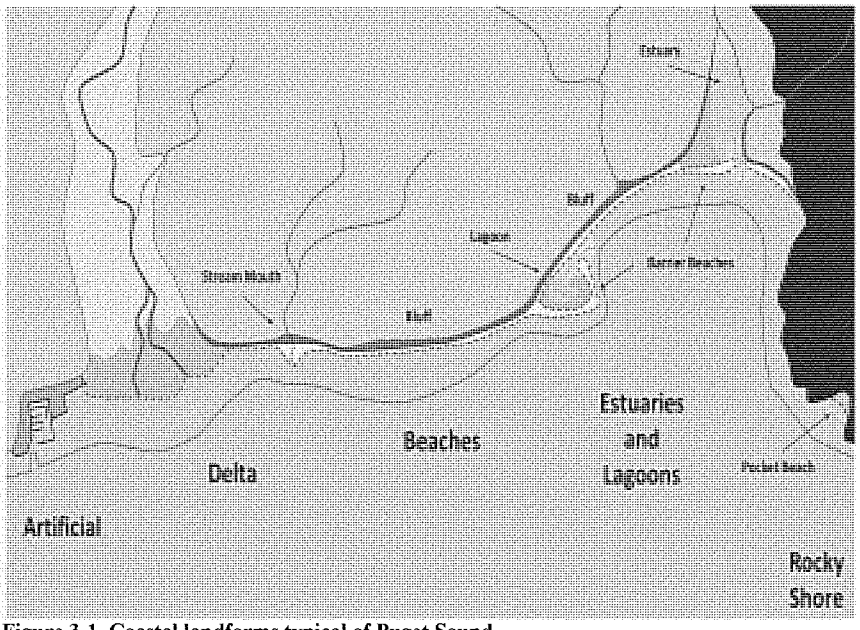
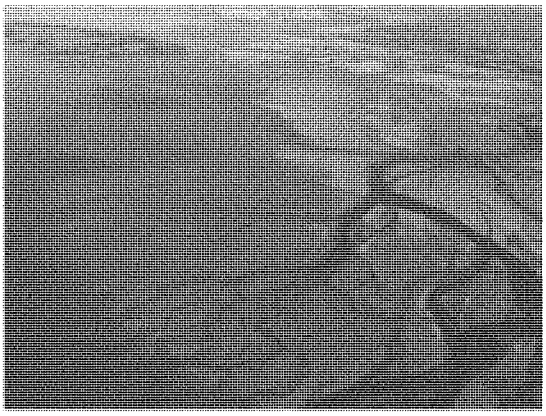
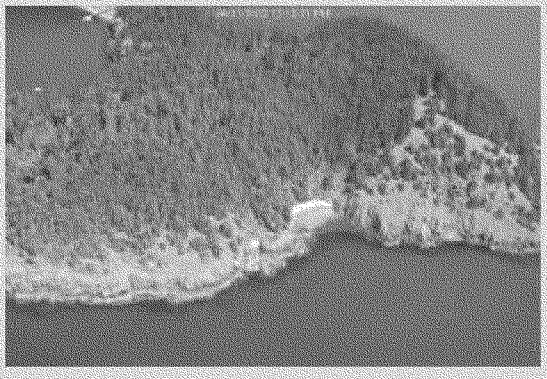
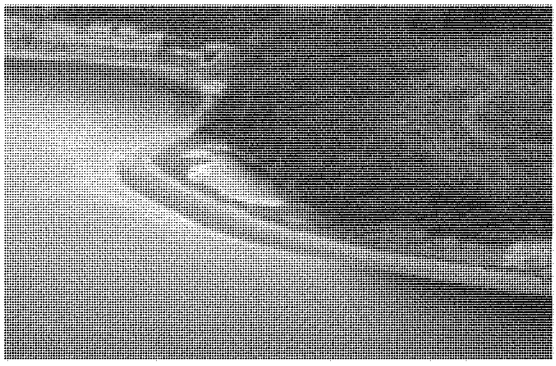
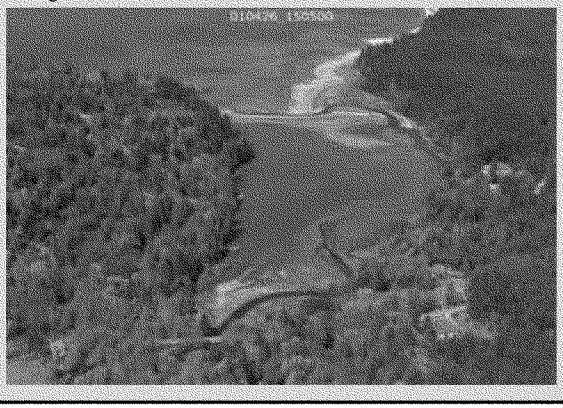


Figure 3-1. Coastal landforms typical of Puget Sound

Table 3-2. Summary of Geomorphic Classification System (Shipman 2008)

System	Landform
River Deltas Long-term deposition of fluvial sediment at river mouths 	**River-dominated deltas** Extensive alluvial valleys with multiple distributaries and significant upstream tidal influence
	Wave-dominated deltas Deltas heavily influenced by wave action, typically with barrier beaches defining their shoreline
	Tide-dominated deltas At heads of bays where tidal influence is more significant than fluvial factors, typically with a wedge-shaped estuary
	Fan deltas Steep, often coarse-grained deltas with limited upstream tidal influence
Rocky Coast Resistant bedrock with limited upland erosion 	**Plunging** Rocky shores with minimal erosion/ deposition and no erosional bench or platform
	Platform Wave-eroded platform/ramp, but no beaches
	Pocket beaches Isolated beaches contained by rocky headlands

System	Landform
Beaches Shorelines consisting of loose sediment and under the influence of wave action 	**Coastal Bluffs** Formed by landward retreat of the shoreline
	Barrier Beaches Formed where sediment accumulates seaward of earlier shoreline
Embayments Protected from wave action by small size and sheltered configuration 	**Open coastal inlets** Small inlets protected from wave action by their small size or shape, but not significantly enclosed by barrier beaches
	Barrier estuaries Tidal inlets largely isolated by barrier beaches and with significant inputs of freshwater from streams or upland drainage
	Barrier lagoons Tidal inlets largely isolated by barrier beaches and with no significant input of freshwater
	Closed lagoons and marshes Back-barrier wetlands with no surface connection to Puget Sound

3.1.3 Oceanography

Puget Sound is the second largest estuary in the United States, composed of many smaller estuarine components with a total shoreline length of more than 2,466 miles. An estuary is a semi-enclosed body of water in which saltwater from a nearby ocean mixes with freshwater runoff from the surrounding watershed. In estuaries, denser saltwater sinks deeper and moves toward the land with tides, while freshwater moves seaward as a surface layer. Shallow sills (submerged ridges that separate basins of water) in Puget Sound's sea floor disrupt tidal movements and promote mixing of the water layers. Exchange of water between estuarine Puget

Sound and saline Pacific Ocean primarily occurs through the Strait of Juan de Fuca, northwest of Puget Sound. Limited exchange occurs through a more obstructed pathway along the eastern side of Vancouver Island, through the Georgia and Johnstone Straits north of Puget Sound. Oceanography of Puget Sound is important to the Nearshore Study because it is a significant factor in the creation and maintenance of landforms (see section 3.1.2). It is a part of the natural processes that contribute to ecosystem structure and function.

Tides

Tides of Puget Sound are mixed-semidiurnal with significant biweekly spring-neap modulation (Mofjeld and Larsen 1984). Thus, twice each day, the shorelines are alternately underwater and exposed to the air, rain, or sun. Beaches can be delineated into zones based on the length of time the substrate is underwater or exposed to air. The *intertidal* zone is between the limits of the tidal highs and lows and is inundated and exposed during each tidal cycle. The *sub tidal* zone is under water except during extreme low tides. The *supratidal* zone, or splash zone, is not frequently inundated except during extreme high tides. Each tidal zone hosts unique assemblages of species. The tidal range around Puget Sound varies depending on location, the geomorphological characteristics, and the distance from the Pacific Ocean. In the mid-sound, the mean tidal range is 7.66 feet and the maximum is 14.4 feet of difference between the lower low and higher high tide. Muted and restricted tidal flows are a problem throughout Puget Sound, particularly in estuaries where the mouth is restricted by causeways and/or much of the adjacent wetlands are cut-off due to levees. Armoring along beaches limits the tidal inundation of higher beach elevations, creating deeper water along the shoreline. Restricted tidal flow affects sediment transport and delivery, detritus import and export, and exchange of aquatic organisms. Shoreline modifications inhibit the habitat quantity, quality, and species diversity of these tidal zones.

Currents

A large volume of water, roughly 1.25 cubic miles, continually moves in and out of Puget Sound with each tidal cycle (Lincoln 2000). The twice-daily exchange of this water produces strong tidal currents through the narrow passages and over the seafloor sills that constrict flows. In addition to the saline water of the Pacific Ocean, freshwater discharge volumes within the Puget Sound watershed contribute to the volume. More than 10,000 rivers and streams drain into the Puget Sound system (WDFW 1975), providing highly seasonal freshwater discharges originating in the Olympic and Cascade Mountain watersheds. The total river discharges range seasonally from a minimum of about 141,000 cubic feet per second (cfs) to a maximum of 3.7 million cfs with a yearly mean of 410,000 cfs. The range in volume of water discharged from the rivers can influence local currents around the deltas. Figure 1-1 (page 3) shows the basins and rivers included within the Nearshore Study area. Levees, jetties, and groins interfere with current patterns that deliver sediment and detritus, and exchange of aquatic organisms within and adjacent to river deltas, as well as along drift cells that run parallel to beaches, which affects habitat quality and quantity.

Waves

Climatic conditions (e.g. storms, wind, etc.) contribute to the wave environment that influences shorelines. Broad regional differences occur in wind patterns and directions within the Puget Sound region, which affect wave energy and its influence on erosion and sediment transport rates within the study area. Exposure to wave action depends on the relative location of the individual shorelines around Puget Sound. The orientation of shorelines to open water is another significant factor. Shorelines that are exposed to considerable expanses of open water, particularly from a northwesterly direction, allow winds to blow unobstructed, creating wave climates having greater amplitudes and frequencies. Long-term exposure of shorelines to these energy conditions influences their physical features, substrate conditions, and susceptibility to erosion.

In Puget Sound, waves are primarily limited by fetch (the distance over water the wind blows), resulting in waves with small to moderate heights and short periods (Downing 1983). An exception is along the Strait of Juan de Fuca and the western side of Whidbey Island, where long-period swell waves can enter from the Pacific Ocean. The irregular shape of Puget Sound, combined with the relatively smaller sizes of its interconnecting basins, produces a fetch-limited environment with significant local variability in wave energy, orientation to winds, and exposure to waves. Prevailing winds come from the south during the winter and from the northwest during the summer; the strongest winds come from the south when winter storms move inland from the eastern Pacific (Mass 2008). The ability of waves to erode the shoreline, particularly feeder bluffs, is severely limited in Puget Sound as much of the shoreline is armored. Wave erosion of bluffs is an essential source of sediment for Puget Sound beaches that are critical spawning habitat for forage fish and migration corridor for salmon among other essential habitat attributes.

3.1.4 Sedimentation and Erosion

Puget Sound beaches are primarily defined by sediment movement driven by wave action, which includes erosion, transport, and deposition of material (Downing 1983, Woodroffe 2002). Sediment movement perpendicular to the shoreline, cross-shore transport, creates the characteristic beach profile. Movement parallel to the shoreline, or longshore transport, redistributes coastal sediment over many miles. Longshore transport is significant in shaping and forming other nearshore ecosystems, including barrier embayments and closed lagoons, which are maintained by spits or other depositional features. Puget Sound sedimentation and erosion is highly episodic. It relies heavily on the sources of sediments and the frequency of the strong storms that contribute sediments to the Sound and redistribute them in the coastal zone. The benefits sought by restoration actions will likely depend on the nature of episodic storm events as well as the quantity of available sediments.

Most beaches of Puget Sound lie within littoral cells (drift cells), which have a net transport of substrate from sediment sources to deposition areas. Beaches can generally be assigned to one of two fundamental geomorphic types: coastal bluffs or barrier beaches. Coastal bluffs occur where the coastline has eroded landward, into upland terrain. Barrier beaches are formed where beach

sediment has accumulated seaward of the original coastline, forming a barrier beach (Shipman 2008). The spatial pattern of bluffs and barriers along Puget Sound's shoreline is complex, reflecting the irregular shape of the shoreline and accompanying local changes in wave energy and orientation, differences in the abundance and texture of sediment sources, and the redistribution of coastal sediment by longshore transport (Finlayson and Shipman 2003). As discussed in the previous section, erosion and sedimentation is severely limited along Puget Sound beaches due to the presence of shoreline armoring and jetties and groins. This armoring restricts the erosion of feeder bluffs that provide a source of sediment input, and groins and jetties interrupt sediment transport to beaches that are down drift.

While coastal embayments of different sizes derive from various geologic origins associated with glaciations, stream channel formation, spatial orientation to wind and waves, and other processes, sediment delivery and transport play a vital role in their geomorphology and functions. Embayments with the same geologic origins and initial morphology can have widely varying geomorphology and functioning due to effects of more recent nearshore processes. The influx of fluvial sediment from contributing watersheds, coastal sediments from adjacent shorelines, volume of sediment relative to embayment size and depth, and the extent of isolation from wave energy and associated sediment transport forces define the complex mosaic of embayment landforms in Puget Sound. Sediment delivery and transport are fundamental shaping processes used to distinguish embayment landforms, including open coastal inlets, barrier estuaries, barrier lagoons, and closed marsh lagoons. In short, these systems are distinguished by the extent to which sediment supply supports depositional features (spits, bars, beaches) that enclose embayments completely, partially, or insignificantly.

River delta systems are dominated by tidal and fluvial processes, and are typically not strongly influenced by littoral (beach) sediment transport and delivery. However, sediment erosion and accretion are still important in delta ecosystem functions. The shape and size of a delta is largely determined by amount and type of sediment available, as well as the configuration of the shoreline near the river mouth. Wave and tidal action redistribute deltaic sediments delivered from the watershed (Wright 1985, Bird 2000, Woodroffe 2002), defining each delta's dynamic shape and size. Upstream of a delta, estuarine wetlands develop where sediment accretion exceeds erosion and subsidence rates. Changes in this balance can lead to erosion of salt marsh and changes to tidal channel morphology (Grossman 2005). Over many decades, this can lead to great differences in geomorphic as well as ecological processes among large portions of a delta.

Sediment input and transport are limited due to causeways and levees that inhibit the erosive forces of tidal hydrology and freshwater input. Jetties and groins at the mouths of large rivers and streams limit the delivery of riverine sediment to adjacent beaches and marine submerged vegetation. Stressors that restrict erosion and sediment dynamics in deltas and embayments also inhibit distributary and tidal channel formation and migration that aid in the delivery of detritus and exchange of aquatic organisms and provide important habitat for aquatic species.

3.1.5 Hazardous, Toxic, and Radioactive Waste (HTRW)

Hazardous, toxic, and radioactive waste (HTRW) sites in the Puget Sound basin are regulated primarily by the EPA and the Washington State Department of Ecology (WDOE) through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, with amendments), and the Washington State Model Toxics Control Act (MTCA). HTRW is defined in ER 1165-2-132 as "any material listed as a "hazardous substance" under 42 U.S.C. 9601 et seq. (CERCLA). (See 42 U.S.C. 9601(14). Hazardous substances regulated under CERCLA include "hazardous wastes" under Sec. 3001 of the Resource Conservation and Recovery Act, 42 U.S.C. 6921 et seq; "hazardous substances" identified under Section 311 of the Clean Air Act, 33 U.S.C. 1321, "toxic pollutants" designated under Section 307 of the Clean Water Act, 33 U.S.C. 1317, "hazardous air pollutants" designated under Section 112 of the Clean Air Act, 42 U.S.C. 7412; and "imminently hazardous chemical substances or mixtures" on which EPA has taken action under Section 7 of the Toxic Substance Control Act, 15 U.S.C. 2606; these do not include petroleum or natural gas unless already included in the above categories." Contamination at a site caused by a spill or other uncontrolled release or an abandoned hazardous waste site meets the definition of HTRW in ER 1165-2-132. If a substance is used for its intended purpose (application of pesticides per labeled directions) or released via a permitted structure (storm water pipe), the substance would not meet the definition as HTRW.

The project sponsor commissioned a Phase 1 Environmental Site Assessment for the sites under initial consideration (USFWS 2012). This report is incorporated by reference.

3.1.6 Water Quality

Water quality is generally defined as the chemical, physical, and biological characteristics of water in a particular area. In Puget Sound, water quality is expressed by a set of parameters that shows the relative health and quality of that water. To determine overall water quality, parameters such as temperature, dissolved oxygen (DO), total dissolved gas, pH, turbidity, and nutrient content are measured.

Puget Sound, as in most large water bodies, has a great deal of variability with respect to water quality parameters across different parts of the water body. Additionally, water quality is influenced a great deal by natural variability, and discerning natural changes from anthropogenic changes is an ongoing challenge. The most recent monitoring data from the Puget Sound Partnership indicates that marine water quality as a whole continues to decrease relative to the baseline. Recent favorable ocean conditions have slowed this apparent decline in areas such as Admiralty Reach and the Georgia Basin, but areas such as Elliot Bay and Budd Inlet continue to decline unabated. The most recent data show the top 50 meters water layer to be warmer than usual from about January to June and cooler than normal in the latter part of the calendar year. Surface temperatures (0-2 meters) in the Central Basin were at or slightly below the long-term average. Water bodies were measured to be slightly saltier than the previous 3 years, although

these values did not approach the values observed in the mid-2000s. Salinities in the Central Basin specifically were typical compared to the long-term average except in May through July, when increased freshwater inputs from snowmelt decrease the overall salinity.

There is a wealth of monitoring data that provide further insight into the existing condition of water quality for Puget Sound. The Puget Sound Ecosystem Monitoring Program (PSEMP) Marine Waters Workgroup releases annual overviews of Puget Sound water quality, as well as quantitative monitoring data for specific basins and water quality parameters. WDOE, along with the PSP, maintains the Marine Water Quality Index, which compares recent parameter data with previous years to create an overall temporal picture of changes in water quality across Washington. Finally, the PSP annually publishes the State of the Sound, which assesses data related to the health of the Puget Sound, including water quality.

3.1.7 Greenhouse Gas Emissions

The Earth's atmosphere is changing, the climate system is warming, and the changes are likely due in part to human activities that produce greenhouse gases (GHGs). GHGs can be produced both naturally and by non-natural human activities such as the combustion of fossil fuels and production of cement. Water vapor is the most abundant of the GHGs and carbon dioxide (CO_2) is the second most-abundant. CO_2 is naturally absorbed during some physicochemical and biological processes, but human activities can also affect these processes. For example, deforestation reduces the amount of CO_2 absorbed by plants via photosynthesis. After CO_2, the most abundant GHGs in the atmosphere are methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). These compounds are produced through both natural processes and human activities. Of the GHGs, water vapor and carbon dioxide have the most significant impact on the greenhouse effect, contributing 36 to 72% and 9 to 26%, respectively (Kiehl and Trenberth 1997).

As a primary contributor to the greenhouse effect and with production and absorption sources closely linked to human activity, CO_2 is typically the focus of GHG discussion. According to NOAA's Earth Systems Research Laboratory, the concentration of CO_2 in the atmosphere increased by 36% from 280 parts per million (ppm) in pre-industrial times to 382 ppm in 2006. The current annual increase in CO_2 concentration is 1.9 ppm/year. Projections for future emissions vary greatly based on the assumptions made about trends in human activities related to CO_2 production and absorption. Generally, however, the scientific community agrees that without significant changes to current policies and practices, CO_2 concentrations in the atmosphere will continue to increase.

3.1.8 Underwater Noise

Anthropogenic activities have increased the ambient sound levels throughout Puget Sound. To analyze the proposed action's potential effects of underwater noise on aquatic resources, some fundamental characteristics of sound and the existing conditions (i.e., the status of underwater

noise in Puget Sound) are laid out here for a basic understanding for the analysis in section 5.1.8. Underwater noise was raised as a concern due to potential construction impacts.

Sources of Sound

Ambient noise is the combination of all sound sources, which creates a steady background noise. Underwater sound source categories are biological (caused by marine life), hydrodynamic (caused by wind, waves, and rain), marine vessel traffic, and seismically produced such as during earthquakes or seismic surveys for oil exploration. Ambient noise conditions underwater in Puget Sound have many contributors including shipping traffic to the Ports of Everett, Seattle, and Tacoma, U.S. Navy activities, the Washington State ferry routes across Puget Sound with up to 23 vessels operating at a time, cruise ships, commercial fishing vessels, and recreational boats. As one example location, permanent ambient underwater noise in Admiralty Inlet, a major route for shipping traffic near Port Townsend, is around 98 decibels (dB) (1 μPa @ 1 m; Bassett 2010). Mean ambient level in most marine waters is 80 to 100 dB (Richardson et al. 1995).

Sources of sound are intermittent as well as ambient. Some temporarily occurring noises include dredging, ships passing nearby, naval sonar testing, and pile driving or other construction-related activities. For example, in addition to the ambient noise in Admiralty Inlet, the Washington state ferry vessel in the Port Townsend-Coupeville route emits roughly 179 dB (1 μPa @ 1 m; Bassett 2010). Small ships around 100 to 150 feet long are common in Puget Sound and their engines emit broadband sound (20 Hz to 1 kHz) at 150 to 170 dB (1 μPa @ 1 m; Richardson et al. 1995). Larger commercial vessels emit lower frequency noise as loud as 170 to nearly 200 dB (1 μPa @ 1 m). Naval active sonar testing is likely the loudest sound produced emitting 230 dB (1 μPa @ 1 m) in the range of 2 to 5 kHz.

Animals in Puget Sound Potentially Affected by Underwater Noise

The major groups of animals in Puget Sound that can be affected by underwater noise are fish, diving birds, pinnipeds (seals, sea lions, and sea otters), and the two types of whales, mysticetes (baleen whales) and odontocetes (toothed whales). The species of focus for this analysis are identified as significant biological resources in section 3.2 or are otherwise protected by the Marine Mammal Protection Act.

Fish can be harmed in different ways, particularly through their swim bladder because of the large difference in impedance between the gas-filled bladder and the surrounding water-filled body tissues (Nedwell et al. 2004). Intense sound pressure waves can cause physical harm and mortality. Fishes' sensitivity to hearing varies, but most exhibit a response to sounds in the range of 50 Hz to 2 kHz, with a minimum threshold around 70 dB (Hastings 1995). Herring, a forage fish with declining populations, have high sensitivity to sound due to their specialization of pressure-sensing mechanisms (Blaxter and Hoss 1981); this is in contrast to Cottids, which have no swim bladder and are therefore not sensitive to sound waves (Nedwell et al. 2004).

Diving birds, such as marbled murrelets, are vulnerable to excessive underwater noise because it affects their ability to catch prey while diving, and can cause disorientation and injury. Excessive noise can cause a range of problems including aborted feeding attempts, disorientation, and even injury if the sound pressure wave is strong enough.

Marine mammals use vocalizations to identify themselves, their location, territory, or reproductive status and communicate with each other about presence of prey, another animal, or danger. Loudness, frequency, duration, and types of sounds vary widely among the species, and can be compared to the audiogram for the species if one has been developed. Audiograms are the graphic display of hearing sensitivity, which plot frequency against hearing threshold. Available data show that whales' auditory thresholds can extend as low as 10Hz for the mysticetes and as high as 500 kHz for some odontocetes (Gordon and Moscrop 1996). California Sea lions are most sensitive to sounds between 1 kHz and 28 kHz with peak sensitivity around 16 kHz (Schusterman et al. 1972). Harbor seals have a slightly broader range with ability to hear up to about 50 kHz for sounds over 60 dB (1 µPa @ 1 m; Richardson et al. 1995). The Steller sea lion hearing range is 500 Hz to 32 kHz with less sensitivity at the low and high frequencies.

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals (Ford 1989). Noise pollution from marine vessel traffic is one of the main concerns with decline in the endangered Southern Resident killer whale population because of how it may affect their vocalizations and hearing. Excessive noise levels may mask echolocation and other signals the species use, as well as temporarily or permanently damage hearing sensitivity (NMFS 2005a). Vessel traffic negatively affects foraging behavior of the Southern Resident killer whales, which can have biologically significant consequences and is likely a factor in their low population level (Lusseau et al. 2009).

3.2 BIOLOGICAL ENVIRONMENT: NEARSHORE FUNCTIONS

Puget Sound is home to approximately 100 species of shorebirds, 200 species of fish (regular inhabitants), 15 species of marine mammals, hundreds of plant species, and thousands of invertebrate species (Sound Science 2007). Many of these species rely in some way on Puget Sound nearshore ecosystems utilizing productive and complex food webs that derive from interactions among terrestrial, nearshore, and deep water/pelagic ecosystems. The following sections of this chapter provide an overview of biota that occupies the nearshore ecosystem, with a focus on the biota of embayments, beaches, and river deltas. Rocky shorelines have unique species assemblages but are not specifically addressed by the Nearshore Study. The results of the change analysis (Simenstad et al. 2011) indicated that from a geomorphic perspective, rocky coast systems are largely unchanged from historic conditions and therefore have not been identified as a restoration priority in Puget Sound (Fresh et al. 2011). Appendix F has more information on the biota of the rocky shorelines. Table 3-3 lists common names for nearshore biota found in the four landforms.

Table 3-3. Nearshore Biota

	Rocky Coast	Beaches	Embayments	Large River Deltas
Vegetation	See Table 1 in Appendix F	Eelgrass and variety of marine macro-algae.	Eelgrass, marine macro-algae, and salt-water and estuarine wetland species.	Eelgrass, estuarine wetland species.
Macro-Invert-ebrates	See Table 2 in Appendix F	Beachhoppers, isopods, amphipods, cancer crabs, barnacles, polychaetes, sea cucumbers, sea stars, shrimp species, sand dollars, Lewis's moon snail, mussels, cockles, and horse, macoma, and geoduck clams.	Amphipods, isopods, copepods, geoduck, horse, and macoma clams, cockles, Olympia and Japanese oysters, cancer crabs, shore crabs, polychaetes, sea slugs, burrowing anemones, and sea and brittle stars.	Crab, shrimp, mussels, anemones, and sea cucumbers in higher salinity marine portions. Isopods, amphipods, oligochaete and polychaete worms, and fly larvae iu brackish marshes.
Fish	Rockfish, kelp greenlings, pricklebacks, wolf eels, perch, many sculpin species such as cabezon and red Irish lord.	Flatfish (sole and flounder), sculpin species, juvenile salmonids, forage fish, and perch.	Flatfish (sole and flounder), sculpin species, stickleback, juvenile salmonids, sturgeon. At high tides in eelgrass beds: bay pipefish, gunnels, shiner perch, and surf smelt.	Flatfish, shiner perch, surf smelt, bay pipefish, salmonids (juvenile and adult), sturgeon, lamprey, longfin smelt, and enlachon.
Marine Mammals	Harbor seals, sea lions, sea otters, killer whales, and northern elephant seals.	Harbor seals, occasionally sea lions (California and Steller), and killer whales.	Harbor seals, occasionally sea lions (California and Steller), and killer whales in larger embayments.	Harbor seals.
Birds	Oystercatchers, harlequin ducks, turnstones, surfbirds, pigeon guillemots, auklets, and belted kingfishers.	Surf scoters, buffleheads, a variety of gulls, mergansers, loons, brants, Canada geese, cormorants, and sandpipers.	Snow geese, brants, gadwalls, American wigeons, teals, plovers, dowitchers, and great blue heron.	Brants, plovers, gadwalls, sandpipers, dowitchers, and great blue herons on mudflats and in estuaries. Mallards, pintails, wigeons, teals, and snow geese in floodplains.

Note: This table is intended to be a *general* rather than comprehensive list of species representative of different Puget Sound landforms. In many cases, species are not endemic to a particular landform, and numerous species that occur in Puget Sound have not been included. (Sources: Kozloff 1973 and 1993, and Dethier 1990)

To relate the benefits of process-based restoration to ecological outcomes, the Nearshore Study team identified a subset of Puget Sound species, species guilds, and habitats, termed "valued ecosystem components" (VECs), that depend on nearshore ecosystems and have social significance to the region's human inhabitants. The relationships between VECs and nearshore ecosystems, documented in peer-reviewed literature, appear in a series of white papers (Buchanan 2006, Dethier 2006, Fresh 2006, Brennan 2007, Eissinger 2007, Johannessen and

MacLennan 2007, Kriete 2007, Leschine and Petersen 2007, Penttila 2007). Conceptual models, restoration objectives, and outreach materials often reference VECs and these documented relationships to nearshore ecosystem process and structures. While not intended to be inclusive of all socially important ecosystem functions, the VEC list does represent a useful cross section of diverse ecological attributes supported by the nearshore zone, including the following:

- Kelp and eelgrass
- Marine riparian vegetation
- Native shellfish
- Forage fish
- Juvenile salmon
- Beaches and bluffs
- Orca whales
- Nearshore birds
- Great blue herons

Species and guilds identified by the Nearshore Study team as VECs that have been used to relate project benefits to ecological outcomes are denoted in this section with an asterisk (*).

3.2.1 Vegetation

Marine Submerged Vegetation

Two main types of submerged marine vegetation inhabit the nearshore zone of Puget Sound: marine algae (which includes kelp and a variety of other seaweeds) and eelgrass. Most marine macroalgae require solid substrate to attach to, but exposure to waves, currents, and sedimentation affect distribution. The highest diversity and abundance of seaweeds in greater Puget Sound occurs in the San Juan Islands and Strait of Juan de Fuca, largely due to the heterogeneity of habitat, exposure to waves and currents, and timing of the tides (Mumford and Dethier, pers. comm., 2010). Native eelgrass generally occurs in intertidal and shallow sub tidal areas throughout Puget Sound (Mumford 2007). The larger perennial species of kelp, bull kelp (*Nereocystis luetkeana*) and giant kelp (*Macrocystis integrifolia*), need consolidated substrate such as bedrock and boulders, and therefore tend to grow more continuously along the rocky shorelines, but kelp beds are not necessarily unique to rocky landforms. Almost all of the 625 marine algal species of Washington can occur on the unconsolidated (boulder/cobble) substrate that is more characteristic of beaches and, in some cases, embayments (Mumford, pers. comm., 2010). Once these kelp and algae detach from their substrate, they typically wash onto Puget Sound beaches providing important nutrients to the upper beach community.

Kelp* plays a critical role in nearshore ecology by providing three-dimensional structure and refuge for a variety of organisms. It has an important role in primary production, directly by serving as a food source for grazers such as urchins and abalone and by providing drift kelp to the shoreline for scavengers, and indirectly by providing a source of carbon for phytoplankton as the kelp decomposes. Floating kelp forests occur primarily along the Strait of Juan de Fuca and the rocky shores of the San Juan Islands, and Puget Sound proper has patchily distributed beds. Non-floating kelp occurs throughout Puget Sound (Mumford 2007). Recent studies have shown that the floating kelp canopy is increasing along the Puget Sound and Strait of Juan de Fuca

shoreline (Berry et al. 2005); however, losses in certain areas such as Bainbridge and Marrowstone Islands and small beds in southern Puget Sound are of concern (Mumford 2007).

Eelgrass* (*Zostera marina*) is the most common native vegetation in intertidal and sub tidal beach habitats of Puget Sound, as well as in embayments with minimal freshwater influence. Large eelgrass beds can grow on the fringes of large river deltas where the salinity is high enough and sediment supply is sufficient. Eelgrass meadow size varies throughout Puget Sound, ranging from a few to several hundred square meters. Biological diversity of eelgrass beds is much higher than that of surrounding areas because the three dimensional structure provides cover and foraging habitat. A variety of epiphytic algae, a critical food source at lower trophic levels, can be associated with eelgrass. Lack of data hinders ability to judge trends in eelgrass populations in Washington (Mumford 2007), although evidence suggests major losses in several large embayments such as Bellingham Bay and the Snohomish River delta and a set of small embayments in the San Juan Islands. Hypotheses for the loss of eelgrass in the San Juan Islands include increases in sediment load, hypoxia, eutrophication, shading by overwater structures, overgrowth by macroalgae, and presence of toxic contaminants (Mumford 2007).

Wetland Vegetation

Wetlands are present in the shallows of many landforms in Puget Sound including barrier estuaries, barrier lagoons, closed marshes and lagoons, and large river deltas. Many of these wetlands have severely declined or been lost due to anthropogenic stressors (see Appendix F for information on wetland trends). Wetlands provide foraging and rearing habitat to a variety of organisms in Puget Sound. Some species use coastal wetlands year-round, and others use the habitat during their transition from freshwater to saltwater. Along the fringes of lagoons (which are typically high salinity marine water), pickleweed (*Salicornia virginica*) and jaumea (*Jaumea canosa*) typically dominate the vegetation communities. Where freshwater is present, as in barrier estuaries, closed marshes, and large river deltas, three types of vegetated wetland classes are present: estuarine mixing, oligohaline transition, and tidal freshwater. These classes transition from more saline to freshwater as one moves upstream. In the estuarine mixing and oligohaline transition wetlands, salt marsh vegetation such as saltgrasses (*Distichlis spicata*) and pickleweed dominate. As the marsh transitions from oligohaline transition to freshwater tidal, Lyngby's sedge (*Carex lyngbyei*), tufted hairgrass (*Deschampsia caespitosa*), bulrush (*Schoenoplectus* spp.), and hooker willow (*Salix hookerii*) become more prevalent. Other vegetation tolerant of the higher salinities in estuaries and lagoons includes arrowgrass (*Triglochin maritima*), saltwort (*Glaux maritima*), seaside plantain (*Plantago maritima*), sea-spurrey (*Spergularia* spp.), gumweed (*Grindelia integrifolia*), and saltbrush (*Atriplex patula*) (Dethier 1990, Cummins pers. comm. 2009). Another class of wetland in Puget Sound is euryhaline unvegetated, commonly called tidal flats. Little vegetation other than diatoms inhabits this wetland type.

Estuarine wetlands have a special regulatory status within Western Washington such that they receive high levels of protection regardless of their size or condition (Hruby 2004). Even so,

much of the salt marsh and wetland habitat has been lost due to the diking and filling of small embayments and tidally influenced portions of the delta and floodplain for the development of pastures, cropland, industry, and urban centers. Some large river deltas have suffered more than others have. For example, the Skagit River delta has lost 74 percent of its historical wetlands (mostly at the upstream area of the estuary), whereas the Duwamish River, which no longer has a recognizable delta, has lost nearly 100 percent of its historical wetlands (Simenstad et al. 2011).

Riparian Vegetation*

Riparian vegetation characteristic of Puget Sound lowlands includes coniferous trees such as western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*). Pacific madrone (*Arbutus menziesii*) occurs in drier areas. Native deciduous trees such as red alder (*Alnus rubra*), big leaf maple (*Acer macrophylla*), and vine maple (*Acer circinatum*) are present if there is disturbance, minimal soil development, and a local seed source to facilitate colonization. Shrubs and understory plants such as ocean spray (*Holodiscus discolor*), Oregon grape (*Mahonia spp.*), Indian plum (*Oemlaria cerasiformis*), and sword ferns (*Polystichum munitum*) are common in riparian areas (Brennan 2007). In addition to regionally common upland plant communities, the nearshore zone is the only location of the wetland communities described above, sand spit vegetation such as dune grass, and coastal bluff prairies (see "Rare Communities" in Appendix F).

Colonization of Puget Sound has resulted in large-scale changes to terrestrial vegetation patterns as a result of agriculture, timber harvest, and industrial and residential development. These disruptions and conversions interfere with natural forest processes, structure, and functions, setting the stage for invasions of non-native species (Brennan 2007). Invasive shrubby species such as Himalayan blackberry (*Rubus armenicus*), butterfly bush (*Buddleja davidii*), reed canary grass (*Phalaris arundinacea*), and Japanese knotweed (*Polygonum* spp.) commonly invade disturbed areas, often so aggressively that they inhibit establishment of native vegetation. In large river deltas, the majority of the forested wetlands and riparian zones are entirely devoid of trees or consist of sparse, narrow, and patchy strips of small- to medium-sized cottonwood (*Populus balsamifera*), willow (*Salix* spp.), and alder. River channelization and bank stabilization with levees have required vegetation removal, which results in the majority of the stabilized banks being covered with grasses and invasive species (e.g., blackberry, knotweed, and reed canary grass) of low value to the native fish and wildlife.

3.2.2 Shellfish and Other Macroinvertebrates

Invertebrates on beaches, embayments, and large river deltas assemble largely according to extent of tidal inundation. In river deltas, invertebrate communities may differ among rivers depending on factors such as the extent of freshwater influence and chemical contamination. Benthic macroinvertebrates in brackish and saline conditions include amphipods, isopods, oligochaete and polychaete worms, and copepods (Cordell et al. 1998). Insect larvae are more prevalent in freshwater. Other invertebrates found in more saline conditions include cancer crabs,

polychaetes, sea cucumbers, sea stars, many shrimp species, and sand dollars (Dethier 1990). Native and introduced oysters can reside in the protected intertidal zones of embayments. Lewis's moon snail and sunflower sea stars are common predators in intertidal and sub tidal zones. Occasionally, giant Pacific and red octopi dwell in the lower intertidal and sub tidal zones (Harbo 2006). Beach hoppers live underneath driftwood in the upper tidal elevations of beaches (Kozloff 1993). In eelgrass meadows and kelp beds, diversity and density of invertebrates increase tremendously with nudibranchs, jellyfish, decorator crabs, sea urchins, sea pens, and a variety of bivalves, shrimp, crabs, and echinoderms.

Shellfish*, mainly clams and oysters, are an important part of the Puget Sound ecosystem and regional economy, and have cultural significance for Native American tribes. Geoduck clams are the largest of the bivalve species in Puget Sound, ranging from the lowest intertidal elevations to depths of 100 meters (Harbo 2006). These large clams can reach over 80 years old. Native Americans and recreational users harvest wild geoduck. Geoduck aquaculture is increasing along beaches and embayments of south Puget Sound and Hood Canal, as demand for overseas export increases. Another shellfish, the native Olympia oyster (see section 3.2.7) has declined dramatically over the past century mainly due to overharvest (Dethier 2006). The Pacific oyster, introduced from Japan, is artificially propagated throughout Puget Sound. Pacific oysters could not sustain themselves as a population without aquaculture efforts as they require higher temperature for reproduction; however, they occasionally reproduce successfully in the wild.

Artificial landforms often attract unique benthic communities. Although many pilings and docks are treated with preservatives to prevent bio-fouling, hardier species move in first, then others follow. Invertebrates commonly found on floats, docks, and pilings include plumose anemones, ochre and sunflower sea stars, tubeworms, and breadcrumb sponges (*Halichondria* spp.) (Kozloff 1993). Other invertebrates may be present, such as sabellid worms, bryozoans, barnacles, mussels, several types of snails, crabs, and shrimp, and native and invasive ascidians.

3.2.3 Fishes

Widely varying fish communities use the nearshore zone where individuals spend all or just portions of their lives. Three general groupings are demersal/reef fish, forage fish, and anadromous fish, although some nearshore species may not fit neatly into a single category. Fish diversity is higher in kelp and eelgrass beds due to the refuge and feeding opportunities provided. At high tide, the diversity of fish species in the nearshore zone increases significantly, especially in eelgrass meadows (Dethier 1990). Information on the three categories of fish follows.

Demersal/Benthic Fish

The demersal/benthic (associated with and located on the bottom) fish category includes fish that use a wide spectrum of habitats including rocky shores, submerged vegetation, and sandy bottoms. Fish found in the rocky/boulder habitat are referred to as reef-dwelling fish; however, they may use areas with softer substrate, particularly if there is structure to hover over, such as

vegetation, sunken boats, riprap, or old pilings. Lingcod is the typical top predator in reef-like habitats. Juvenile rockfish often hide in understory kelp and rocky crevices (Hayden-Spear and Gunderson 2007), and certain species use areas as shallow as tide pools (Love et al. 2002). A few rockfish species forage in shallow areas as adults. A variety of sculpin use reef habitats to rest on the bottom and feed on the abundance of invertebrates indicative of rocky substrates. Kelp greenlings, pricklebacks, wolf eels, gunnels, and shiner perch forage in and around rocky substrates and their associated kelp forests. Demersal fish more typical of softer substrate include flatfish such as sole and flounder, certain sculpin species, and the occasional rockfish species. Occasionally, deepwater fish such as spiny dogfish, ratfish, eelpout, Pacific tomcod, and hake may enter the shallows of the nearshore zone to feed.

Forage Fish*

The three species of small schooling fish that are most highly dependent on the nearshore zone are Pacific herring, Pacific sand lance, and surf smelt. Collectively referred to as "forage fish", their sheer abundance makes them a primary food source for a many marine fish and birds, particularly salmonids. These three species are highly dependent on nearshore habitats and substrate for spawning (Penttila 2007). Sand lance and surf smelt spawn in the upper intertidal zone of sand/gravel beaches leaving their eggs to incubate in the substrate. Their spawning areas are common throughout Puget Sound. Pacific herring spawn almost exclusively in the shallow sub tidal and lower intertidal zones, mainly on eelgrass and kelp. Other forage fish species, such as longfin smelt and eulachon, use river deltas for spawning (see Appendix F).

Anadromous Fish

Fifteen native species of anadromous fish use marine and freshwater of the Puget Sound area. These include all five species of Pacific salmon (pink, Coho, chum, Chinook, and sockeye), two species of native char (bull trout and Dolly Varden), steelhead and coastal cutthroat trout, longfin smelt, eulachon, white and green sturgeon, and two species of lamprey. Salmon are discussed in more detail because of their ecological, cultural, and economic importance in Puget Sound. For detailed information on other anadromous fish that occur in Puget Sound, see Appendix F.

Salmonids: The most well-known anadromous fish in Puget Sound are salmonids (salmon, trout, and char). Several agencies monitor salmonid populations due to the ecological and economic importance and declining numbers (warranting the listing of several species on the Endangered Species List). Pacific salmon, in particular, have a critical role in Puget Sound's ecosystem dynamics. Known as a keystone species (Willson and Halupka 1995), Pacific salmon are a food source for many marine, freshwater, and land animals and provide marine nutrients to freshwater environments post-spawning (Cederholm et al. 1999). All salmonids spawn in freshwater gravel substrates where the eggs incubate and hatch.

Although most species and life history stages of salmonids can be observed in nearshore areas, juvenile salmonids* typically use these ecosystems extensively as a migration corridor and

foraging habitat; however, not all species or runs within a species use the nearshore zone in the same way (Fresh 2006). For example, Chinook and chum use coastal embayments and non-natal estuaries from other rivers whereas steelhead do not. As the juveniles grow, they expand their range into deeper water before migrating to the North Pacific Ocean, with the exception of a few runs that are Puget Sound residents (Fresh 2006). As adults, large salmonids such as steelhead and Chinook typically only use the larger rivers for spawning, but pink, chum, and Coho salmon adults can transit small embayments en route to their spawning grounds in smaller streams that flow into Puget Sound. Adult bull trout use the nearshore areas along beaches and at the entrances of embayments and large river deltas as foraging habitats.

Salmonid use of the nearshore zone depends on the species, the particular run of a species, and environmental conditions. Dendritic tidal channels in large river deltas are an important feature for juvenile rearing and smoltification (Beamer et al. 2005, Fresh 2006); however, much of this off-channel habitat has been lost in large river deltas due to diking of rivers for development of floodplains. See Appendix F for information on population trends of salmonids in Puget Sound.

3.2.4 Birds

Approximately 100 bird species utilize Puget Sound nearshore ecosystems. Shorebirds* forage along the beaches at the tide line in search of benthic invertebrates that are close to the surface; representative species include spotted sandpipers, surf scoters, dunlins, Western sandpipers, yellowlegs, and turnstones. Embayments and river deltas host a variety of birds that are attracted to abundant eelgrass beds, salt marshes, and mudflats. Birds associated with tide flats include snow geese, brants, gadwalls, American widgeons, mallards, pintails, teal, plovers, sandpipers, and dowitchers (Buchanan 2006). Great blue herons* forage on a variety of fish and invertebrates in shallow pools, mudflats, and eelgrass beds during low tides (Eissinger 2007). American bitterns, Virginia rails, marsh wrens, savannah wrens, song sparrows, and common yellow throats nest and forage in and around salt and freshwater marshes.

In fall and winter, the more agriculturally developed river deltas, such as Skagit and Snohomish, host large numbers of snow geese and trumpeter swans that feed on vegetation in shallows and agricultural fields. The trumpeter swan, once an endangered species, has increased in numbers in Skagit County from a 1963 population of 20 to several thousand today. Other shorebirds, such as dunlin and black bellied plover, use flooded agricultural fields and estuaries mainly during migration and in winter. Several species of raptors appear throughout Puget Sound including bald eagle, red-tailed hawk, rough-legged hawk (winter only), northern harrier, gyrfalcon (winter only), peregrine falcon, merlin, Cooper's hawk, sharp-shinned hawk, and osprey. The Skagit Delta hosts one of the largest wintering populations of raptors in the contiguous United States. In heavily urbanized river deltas such as the Duwamish River estuary, abundance of birds is much lower due to lack of foraging and nesting habitat.

More widely distributed birds throughout Puget Sound include cormorants, grebes, loons, crows, geese, and a variety of gulls. Some of these, such as cormorants and gulls, take advantage of human-made shoreline structures for nesting and foraging. A variety of passerines, also known as song and/or perching birds, nest and forage in riparian areas of rivers and along the shoreline.

3.2.5 Mammals

Marine

Harbor seals are the most common marine mammal, found throughout Puget Sound, often seen basking on rocky outcroppings, beaches, and occasionally human-made structures. They occasionally enter rivers and may travel several miles upstream. Steller sea lions visit the San Juan Islands every fall to rest and forage before they go to coastal rookeries to mate. California sea lions, northern elephant seals, and sea otters visit Puget Sound, though not in large numbers. Killer whales*, also known as orcas, are top predators in Puget Sound. These whales appear most frequently around the San Juan Islands; however, they occasionally explore other areas of Puget Sound. Of the four types of killer whales in the northeastern Pacific, only the Transients and Southern Residents are common in the San Juan Islands and greater Puget Sound region; the Offshores and Northern Residents rarely enter Puget Sound (Kriete 2007). Transient killer whales feed on marine mammals such as harbor seals, sea lions, and porpoises, and their presence is rather unpredictable. The Southern Residents regularly occur among the San Juan Islands and occasionally in Puget Sound; they feed almost exclusively on fish, primarily Chinook and chum salmon. The Southern Residents are ESA-listed as endangered (see section 3.2.7).

Freshwater and Terrestrial

If freshwater is present or a stream is nearby, river otters may forage and play in embayments and at the mouth of rivers. Beaver, muskrat, and mink inhabit upstream portions of the many streams and rivers that flow into Puget Sound. Terrestrial mammals such as black tail deer, raccoon, weasels, opossum, coyote, and a variety of small mammals inhabit riparian areas and occasionally browse the shoreline. Carlton and Hodder (2003) introduced the term "maritime mammal" and have documented many predation events by terrestrial mammals that forage specifically in marine intertidal areas; the majority of records involved raccoon, mink, and black bear on shores of the Eastern North Pacific Ocean. Habitat areas have significantly decreased due to urbanization and industrialization around Puget Sound.

3.2.6 Aquatic Invasive Species

Biological monitoring of Puget Sound in the last 20 years has identified many exotic species that have invaded the region. At least 52 non-indigenous marine species inhabit Puget Sound based on a comparison of listings by WDFW and researchers (Cohen 2004). Ray (2005) found 125 non-indigenous marine and estuarine animal species in the State of Washington by querying lists maintained by the Smithsonian Institution (*www.nisbase.org*). In Ray's (2005) report sponsored by the Corps' Engineer Research and Development Center, there are 12 invasive marine animal

species deemed most threatening to Corps habitat restoration efforts in Washington. These include several species of clams and mussels as well as Atlantic salmon and green crab. In addition, the Washington State Aquatic Nuisance Species Management Plan (Meacham 2001) identifies nine marine plant species as present in Washington, including *Pseudo-nitzchia australis*, the algae linked to domoic acid and shellfish poisoning in humans. Shipping imports for aquaculture and fisheries provide the dominant pathways for marine invasion within this region (Wonham and Carlton 2005); however, human modification of shorelines, including marina development, can increase the likelihood of spread as exotic species fill voids following native habitat loss. See Appendix F for more specific information on aquatic invasive species.

3.2.7 Rare, Threatened, and Endangered Species

Puget Sound supports numerous rare, threatened, and endangered species. Many of these have specific ecological niches that are vulnerable to multiple anthropogenic pressures including habitat loss, overharvest, and pollution. Some have protection under the ESA; others are recognized at the state level, and some have no formal protection status but have been identified as rare by the conservation community. Plants discussed herein have been identified as rare on the Washington Department of Natural Resources (WDNR) Natural Heritage website. Species discussed below use nearshore ecosystems either **directly** as habitat (exclusively or intermittently), **indirectly** by foraging for species that have a strong dependence on the nearshore zone, or **intermittently** by occasionally using the nearshore habitats, including use as migratory corridors. Details on distribution, population status, and threats to each of these species appear in the following sections. Appendix F provides additional information on life history and population status on rare, threatened and endangered species.

Southern Resident Killer Whale (Orca)

Due to the low numbers and potential threats, Southern Resident killer whales are ESA-listed as endangered (NMFS 2005a). Critical habitat is designated as marine water more than 20 feet deep in Puget Sound, San Juan Islands, and Strait of Juan de Fuca (NMFS 2006b). Southern Resident killer whales (*Orcinus orca*) occur in Puget Sound from early spring to late fall until they move to the coast for the winter. Southern Resident killer whales eat a variety of fish and squid, but have a strong feeding preference for chum and Chinook salmon, which rely heavily on the nearshore zone for juvenile rearing. Southern Resident killer whales are often around the San Juan and Gulf Islands, the surrounding straits, and the eastern end of the Strait of Juan de Fuca, sometimes playing and foraging in shallow kelp beds adjacent to rocky shorelines (Kriete 2007). In the fall, the whales may expand their range in Puget Sound to the south in pursuit of local salmon runs before leaving for their winter habitat outside of Puget Sound (Kriete 2007).

Three matrilineal pods of Southern Resident killer whales frequent Puget Sound, named J, K, and L pods, numbered at 82 individuals for all three pods in 2015. Threats to this population include decline in prey abundance, presence of toxic substances, and whale-watching vessel traffic. Concentrations of contaminants in Southern Resident killer whale are some of the highest

of any marine mammal in the world (Kriete 2007). In addition, the Southern Resident pods are relatively small, reproductively isolated, and face the risk of population decline through inbreeding effects. Currently, these pods have few reproductive males and females, and the loss of a key reproductive male or female could stunt population growth for years until another individual reaches maturity, which typically occurs at 10 to 15 years of age (Perrin and Reilly 1984). The social cohesion within pods concentrates individuals within a relatively close extent; this can lead to large population declines resulting from one catastrophic event.

Humpback Whale

Due to past commercial exploitation, humpback whales are ESA-listed as endangered. Although humpbacks were one of the more common cetacean species in Puget Sound in the early 1900s, they are now sighted only intermittently (Calambokidis and Steiger 1990). Humpback whales (*Megaptera novaeangliae*) have at least three different populations in the North Pacific Ocean. This population winters in coastal Central America and Mexico and migrates to areas ranging from the coast of California to southern British Columbia in summer/fall (NMFS 2013). The California/Oregon/Washington stock is relevant to this project. Humpbacks are increasing in abundance in much of their range. In the North Pacific, humpback abundance was fewer than 1,400 whales in 1966 after heavy commercial exploitation. The current abundance estimate for the North Pacific is about 20,000 whales. Recent increases in the population have resulted in more frequent sightings in Puget Sound and along the Strait of Juan de Fuca. Humpbacks observed in Puget Sound do not remain for long periods and are considered stragglers. Threats to humpbacks include entanglement in fishing gear, boat strikes, whale watch harassment, and habitat degradation (NMFS 2013).

Sea Otter

Sea otters (*Enhydra lutris*) range from Southern California to the Aleutian Islands in Alaska, in non-contiguous patches. The Washington population is listed as endangered by the State of Washington due to its small size, restricted distribution, and vulnerability. The southern population, in California, and the northern population, in Alaska, are each listed as a federally threatened species; however, the Washington and British Columbia populations are separate and not ESA-listed (USFWS 1977; USFWS 2004). Sea otters almost never leave the water where they inhabit the shallow kelp forests of the nearshore zone and prey on a variety of invertebrates (Haley 1986).

Historically, sea otters inhabited the entire west coast of North America, but harvest for pelts that began in the 1700s extirpated them from many areas, including Washington. In 1969 and 1970, sea otters were reintroduced to the Washington coast from Alaska. Surveys indicate that the sea otter population is gradually increasing in Washington State and in British Columbia off Vancouver Island. Most of the Washington population is on the northern coast and the western Strait of Juan de Fuca; however, sightings have occurred as far south as Olympia and more

frequently in the San Juan Islands (Lance et al. 2004). Threats to sea otters in Washington include oil spills, infectious disease, and entanglement in fishing nets (WDFW 2012b).

Hood Canal Summer Chum Salmon

The Hood Canal Summer-Run chum salmon Evolutionarily Significant Unit (ESU) is ESA-listed as threatened (NMFS 2005b). Critical habitat exists throughout Hood Canal and its tributaries, which are all considered part of the Puget Sound Basin. Chum salmon (*Oncorhynchus keta*) range from Monterey, California to the Arctic coast and Beaufort Sea along the coast of North America. Juvenile chum salmon use small coastal embayments and eelgrass beds as foraging grounds and refuge from predators before migrating to the Pacific Ocean (Fresh 2006). Chum salmon use their natal estuaries extensively for rearing and foraging during outmigration to the ocean.

Six of the eight summer chum salmon stocks within the Hood Canal ESU have decreased in abundance with return stocks below viable replacement levels (Fresh 2006). The Hood Canal summer chum populations have been declining since 1978. The Strait of Juan de Fuca populations have been declining since 1988 and although they are not declining as rapidly as those in Hood Canal, these populations are at very low levels. Threats to Hood Canal summer-run chum include degradation of habitat, harvest, and low water flows in the Hood Canal watersheds (Johnson et al. 1997). The Duckabush estuary site will provide an opportunity to restore habitat and increase populations within Hood Canal for Summer Chum Salmon.

Puget Sound Chinook Salmon

The Puget Sound Chinook salmon ESU found east of the Elwha River is ESA-listed as threatened (NMFS 2005b). Critical habitat exists throughout Puget Sound and its tributaries. Chinook salmon (*Oncorhynchus tshawytscha*) range from central California to Kotzebue Sound, Alaska. Puget Sound populations are largely summer/fall runs, which are typically considered ocean-type fish (migrating to marine water within their first year). They are found in most river and tributaries in Puget Sound, Hood Canal, and Strait of Juan de Fuca. Like chum, juvenile Chinook, particularly ocean-type, have a have a strong dependence on their natal estuary during outmigration to the ocean and use small coastal embayments and nearshore areas while rearing along the shoreline before migrating to the North Pacific Ocean (Fresh 2006). Few Chinook salmon (called residents) reside year-round in Puget Sound (Pressey 1953, Brannon and Setter 1989).

Abundance estimates indicate that most populations are at a small fraction of their historic levels; several populations within the Nooksack, Lake Washington, mid-Hood Canal, Puyallup, and Dungeness basins have returns of fewer than 200 adult fish, signifying extinction risk. The Nooksack river delta site will provide a rare opportunity to restore a large river delta area that will increase severely degraded populations of salmon in this river system. Only the upper-Skagit stocks have returns of native (non-hatchery) fish in excess of 10,000 adults. The North Fork river

delta site is located at the confluence of the Skagit River and is critical to these native fish returns by providing scarce river delta and estuary habitats that are necessary for life cycle requirements of these salmon. A 1998 status review indicated a decline of 1.1 percent per year; more recent calculations indicate a slower decline (Shared Strategy 2007). Threats to Puget Sound Chinook salmon include diking, draining, and filling of freshwater and estuarine wetlands; sedimentation of upper tributaries due to timber harvest; and blockages and altered hydraulic regimes from dams (Good et al. 2005).

Puget Sound/Strait of Georgia Coho Salmon

Coho salmon (*Oncorhynchus kisutch*) range from central California to the Bering Sea to along the coast of North America. NMFS (2009c) identified Puget Sound/Strait of Georgia Coho as a Federal Species of Concern. While in Puget Sound, juvenile and sub-adult Coho migrate and forage along the shoreline before migrating to the Pacific Ocean. A few coastal and inland Coho salmon stocks reside year-round (called residents) in Puget Sound (Weitkamp and Neely 2002).

Stocks in Puget Sound range from healthy to critical (WDFW 2002). Three stocks in Puget Sound/Strait of Georgia are at high risk of extinction and one as possibly extinct (Nooksack River) (Nehlsen et al. 1991). None of the stocks identified as healthy are strictly of wild origin. Bledsoe et al. (1989) reported an 85 percent decline of Coho salmon runs in South Puget Sound from 1896-1975. Hatchery production is a major threat to Puget Sound/Strait of Georgia Coho by way of genetic outbreeding and homogenization, as many hatchery strains are from out-of-basin sources. Other threats include loss of habitat and unfavorable ocean conditions (NMFS 2009c).

Coastal/Puget Sound Bull Trout

Bull trout (*Salvelinus confluentus*) are native char of Washington, Oregon, Idaho, Nevada, Montana, and western Canada. Puget Sound bull trout are ESA-listed as threatened (USFWS 1999). Critical habitat exists throughout much of Puget Sound and its tributaries. Unlike Pacific salmon, anadromous bull trout are year-round residents of the Puget Sound basin. In marine water, sub-adult and adult bull trout commonly forage in shallow nearshore habitat and natal and non-natal estuaries along the shoreline, but usually return to their natal estuary to migrate upstream to spawn.

Bull trout populations have declined throughout much of the species' range; some local populations are extinct, and many other stocks are isolated and may be at risk (Rieman and McIntyre 1993). Insufficient data exist to confidently estimate bull trout abundance for many core areas and for the entire management unit (Shared Strategy 2007). Combinations of factors including habitat degradation, expansion of exotic species, and exploitation have contributed to the decline and fragmentation of bull trout populations.

Puget Sound Steelhead

Steelhead (*Oncorhynchus mykiss*) range from Kamchatka in Asia, east to Alaska, and south along the Pacific Coast to about the U.S.-Mexico border (Busby et al. 1996). Puget Sound steelhead are ESA-listed as threatened (NMFS 2007b). Relative to the longer nearshore rearing periods of other juvenile salmonids, steelhead smolts outmigrate to offshore areas quickly and the transit time through the estuary is brief (days to weeks).

In the last 10 years, Puget Sound steelhead populations have decreased at a steady pace with marked decreases seen within the Strait of Juan de Fuca, Bellingham Bay, Hood Canal, and South Puget Sound. The more intense population declines since 1990 in Puget Sound mimic declines of steelhead in British Columbia along the Strait of Georgia and eastern Vancouver Island. Speculated causes of these declines include climate change, hatchery production, harvesting, and increased UV radiation (Hard et al. 2007).

Green Sturgeon

Green sturgeon (*Acipenser medirostris*) are a broadly distributed fish ranging from Mexico to Alaska along the coast of North America. The southern distinct population segment (DPS) of green sturgeon is ESA-listed as threatened (NMFS 2006a). No critical habitat is designated in Puget Sound proper (NMFS 2009a). Although no freshwater spawning habitat occurs in Puget Sound, green sturgeon use the nearshore zone as foraging habitat. Population declines of the southern DPS of green sturgeon are due to a reduction in spawning area to a limited number of rivers including the Sacramento, Rogue, and Klamath, and have little to do with Puget Sound. Other threats include insufficient freshwater flow rates, contaminants, bycatch, impassible barriers, and elevated water temperatures.

Rockfish (Bocaccio, Canary, Yelloweye)

Bocaccio (*Sebastes paucispinis*) range from northern British Columbia to central Baja California. Juveniles are the most abundant life stage occurring in the nearshore zone where they hover over rocky substrate with various understory kelps or sandy bottoms with eelgrass. Due to declining numbers, bocaccio are ESA-listed as endangered (NMFS 2009b). Threats to bocaccio include direct fishing and by-catch, which led to recruitment failure in the early 1990s (NMFS 2009b).

Canary rockfish (*Sebastes pinniger*) range from northern British Columbia to northern Baja California, potentially living to be 80+ years old. Juveniles are the most abundant life stage in the nearshore zone where they hover over rock-sand interfaces and sand flats. Due to declining numbers of canary rockfish in Puget Sound, they are ESA-listed as threatened (NMFS 2009b). Threats to canary rockfish are the same as those for bocaccio.

Yelloweye rockfish (*Sebastes ruberrimus*) range from the eastern Aleutian Islands to Northern California and can live up to 118 years. Due to declining numbers, they are ESA-listed as threatened (NMFS 2009b). Adults, sub-adults, and juveniles occupy the nearshore areas with rocky substrate. Threats to yelloweye rockfish are the same as those for the other rockfish.

Eulachon

Eulachon (*Thaleichthys pacificus*) are a small anadromous fish in the eastern Pacific Ocean that range from California to Vancouver Island, including northern Puget Sound. The southern DPS of eulachon is ESA-listed as threatened (NMFS 2010). No spawning areas are documented in Puget Sound. The only documented eulachon spawning near the project area is the Elwha River in the Strait of Juan de Fuca (designated as critical habitat) and the Fraser River in southern British Columbia (NMFS 2011); however, migrants from the northern population likely forage in areas of the Puget Sound nearshore zone that extend beyond their spawning range (Goetz pers. comm. 2009).

Eulachon abundance exhibits considerable year-to-year variability; however, nearly all spawning runs from California to southeastern Alaska have declined in the past 20 years, especially since the mid-1990s. From 1938 to 1992, the median commercial catch of eulachon in the Columbia River was approximately 2 million pounds (900,000 kg), but from 1993 to 2006, the median catch declined to approximately 43,000 pounds (19,500 kg), representing a nearly 98 percent reduction in catch from the prior period (Gustafson et al. 2010). Threats to eulachon include habitat loss and degradation of spawning grounds via dams, siltation, and dredging, and potentially chemical pollution (Gustafson et al. 2010).

Marbled Murrelet

Marbled murrelets (*Brachyramphus marmoratus*) are small marine diving birds that range from southern California to Alaska. They are ESA-listed as threatened (USFWS 1992). Critical habitat includes upland forested stands used for nesting, but does not include marine water. Murrelets are common winter residents of Puget Sound, especially the northern portions. Forage habitat is deeper water in entrance channels of rocky shores, estuaries, and protected bays where the birds can dive in pursuit of forage fish, which are dependent on nearshore habitat (Angell and Balcomb 1982).

Few data are available to interpret trends in population; however, there was an estimated 51 percent decline in north Puget Sound between 1978 and 2003 (Huff et al. 2006). Recent trends indicate a continued steady decline of marbled murrelets, with a decrease in population of 7.9 percent from 2000 to 2009 in Puget Sound and the Strait of Juan de Fuca (USFWS 2009). The marbled murrelet population estimate for Puget Sound and Strait of Juan de Fuca in 2010 was around 4,400 birds (Pearson et al. 2011a). Threats include habitat loss from timber harvest 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.

Northern Abalone

Northern, or pinto, abalone (*Haliotis kamtschatkana*) range from Alaska to Mexico. NMFS lists northern abalone as a Federal Species of Concern (NMFS 2007b). In Washington, they inhabit rocky shorelines with significant kelp cover around the San Juan Islands and the Strait of Juan de

Fuca. Although there has never been a commercial fishery for northern abalone in Washington State, sport harvests continued into the mid-1990s. Declining numbers triggered WDFW to close the recreational harvest in 1994; however, populations continue to decline (Puget Sound Restoration Fund 2009). Reasons for the continued decline include the Allee effect (in which individuals are too far from each other for successful fertilization), water quality conditions, and poaching.

Olympia Oysters

Olympia oysters (*Ostrea lurida*) historically ranged from southeast Alaska to Baja California. Olympia oysters are a State Candidate Species in Washington meaning they are under review for listing as State endangered, threatened, or sensitive. Oyster reefs often occur between eelgrass beds and mudflats, where they filter-feed on plankton and other matter (Dethier 2006). Although they were once abundant in shallow sub tidal zones of southern Puget Sound in wild and cultured forms, natural reproduction of Olympia oysters has nearly disappeared. Factors leading to the decline include overharvest, siltation, and domestic and industrial pollution of estuaries. Other stressors include predation from invasive drilling snails and flatworms, and displacement by culture of the hardier introduced Japanese oyster (*Crassostrea gigas*) (Dethier 2006).

California Buttercup

California buttercup (*Ranunculus californicus*) grows in open grassy areas, rocky slopes along the coast, and in rocky wooded areas from southern California to southern Vancouver Island. It is listed as a rare plant by the WDNR Natural Heritage Program (WDNR 2009). It tends to be associated with Sitka spruce, Douglas fir, and madrone, and dryer areas such as grasslands. Very few sites in Puget Sound still contain California buttercup and presently are only around the coastline of the San Juan Islands. Given the small range, any disturbance via grazing, development, or recreation can be a threat (WDNR 2009).

Sharpfruited Peppergrass

Sharpfruited peppergrass (*Lepidium oxycarpum*) grows in the salt spray zone from central California to Victoria, British Columbia. In Washington, it is listed as a rare plant by the WDNR Natural Heritage Program. This plant grows in moist cracks and vernal pools and in sand or saline soil in direct sunlight along the coastline. The only known occurrence of Sharpfruited peppergrass in Washington is on the coastline of the San Juan Islands. Given the small range, any disturbance via grazing, development, or recreation can be a threat (WDNR 2009).

Golden Paintbrush

Golden paintbrush (*Castilleja levisecta*) historically occurred at many sites in Puget Sound, British Columbia, and as far south as the Willamette Valley in Oregon. It has been extirpated from the majority of these sites, including all of Oregon, and it is ESA-listed as threatened (USFWS 1997). It occurs in open grasslands at low elevations around the perimeter of Puget Sound. Most remaining populations are in the San Juan Islands and on Whidbey Island. Loss of

golden paintbrush is associated with the conversion of grasslands to agriculture, and residential and commercial development (WDNR 2009).

3.3 CULTURAL RESOURCES

Cultural resources encompass a wide range of historic and cultural places and property types. Buildings, structures, and sites; groups of buildings, structures, or sites forming historic districts; landscapes; and individual objects may be eligible for listing in the National Register of Historic Places (National Register) if they meet three main standards: age, significance, and integrity. Resources must be 50 years old or older for National Register consideration, although more recent properties may be determined eligible if they possess exceptional significance. To be significant, a property must have a demonstrated association with events, activities, or developments that were important in the past; with the lives of people who were important; or have potential to yield information through archaeological investigations. Integrity refers to the ability of a property to demonstrate significance through the retention of aspects of location, design, setting, materials, workmanship, feeling, and association. The term "historic properties" refers to cultural resources that are either eligible for or listed on the National Register.

Preliminary investigations to identify historic properties at all 36 proposed restoration sites included a records/literature review and reconnaissance-level survey work (see annotated bibliography). The records/literature search was designed to identify any known (previously recorded) potential cultural resources as well as the extent and location of previous cultural resource investigations. Materials reviewed included reports, field notes, and site forms at the Washington State Department of Archaeology and Historic Preservation and various historical, ethnographic, and environmental documents. The findings are summarized in a confidential report, restricted in distribution due to the sensitive nature of cultural resource information. Conceptual design reports prepared for restoration sites identified several additional buildings and structures potentially historic in age. Reconnaissance-level surveys occurred at 18 sites. Only areas where landowners granted access were considered for investigation. Pedestrian archaeological surveys were further limited to sample areas based on various environmental factors and extent of previous cultural resource investigation and site finds. Additionally, no "occupied" buildings were inventoried. The Corps considers the survey's findings and recommendations are considered baseline and further investigation at each of the proposed sites is needed to determine the presence/absence of unidentified archaeological resources and to evaluate the previously recorded sites. In addition, further inventory of historic structures is necessary.

Common archaeological sites found in the Puget Sound nearshore zone include the following types:

- Occupation sites such as prehistoric hunting camps, prehistoric and ethnohistoric villages, as well as early Euro-American cabins, and farms
- Prehistoric and Ethnohistoric Shell Middens

- Prehistoric and Ethnohistoric Lithic Assemblages/Scatters
- Cemeteries (both prehistoric and historic)
- Railroad camps associated with the construction of railroads and other transportation methods (roads, bridges)
- Logging camps

Common historic buildings and structures found in the Puget Sound nearshore zone include the following types:

- Levees and dike systems
- Canneries
- Early pioneer houses and farming complexes (barns, sheds, fences, and orchards)
- Roads and bridges
- Railroads
- Sawmills

3.4 SOCIOECONOMIC RESOURCES AND HUMAN ENVIRONMENT

The Puget Sound ecosystem is a cornerstone of the region's prosperity and quality of life. People from around the world are drawn to the Puget Sound region because of the dynamic economic opportunities and abundant natural assets the region offers. Puget Sound is bordered by 12 Washington counties and is home to 4.3 million people or over 70 percent of the State's total population (U.S. Census Bureau 2010). The Seattle Metropolitan Statistical Area (MSA) is the population center and economic engine of the Puget Sound Region. The Seattle MSA encompasses three of these 12 counties; with a total 2010 population of over 3.5 million, it is the 15th largest metro area in the U.S. (U.S. Census Bureau 2010).

Puget Sound serves as the major North American gateway for trade with Pacific Rim countries. Together the ports of Seattle and Tacoma make the Puget Sound the second largest U.S. harbor for container traffic. The Puget Sound ecosystem—among the most productive and ecologically diverse in the U.S.—supports one of the largest commercial shellfish fishing and aquaculture industries in the country. Visitors and local residents alike enjoy a thriving outdoor recreation industry including such water-related activities as sportfishing, whale watching, shellfishing, kayaking, and scuba diving. These commercial and recreational activities are dependent upon the ecosystem functions that come from the "natural capital" (i.e. ecosystem elements of geology, water and nutrient flow, native plants and animals, etc.) of the Puget Sound environment (Earth Economics 2008). The following sections describe the socioeconomic resources and human environment with a focus on how the natural capital of the Nearshore Study area benefits the socioeconomics of Washington State.

3.4.1 Shoreline Ownership and Land Use

Washington has an unusual patchwork of public and private tideland ownership along its shoreline. Unlike some coastal states, Washington's tidelands and beaches are not all in public ownership. Based on a public access study by WDOE (2009b), 62% of the State's marine waterfront property is privately owned (or 1,898 of 3,065 miles). The State Legislature elected to sell tidelands and beaches in 1889 and continued sales for many years. In 1971, the State ceased all sales of tidelands to private entities. The boundaries and ownership of tidelands are complex due to changes in the law.

Various entities hold adjacent upland ownership. Some areas are predominantly residential in private ownership, supporting vacation and retirement communities. Other areas are in state or local government ownership for public recreational use or for transportation features or infrastructure related to ports and harbors. Private industries, especially those that are water-dependent for production or distribution of goods, are another common owner of adjacent uplands. Size and density of adjacent upland parcels often reflect proximity to urban centers. Agriculture is a common land use type across many of the Puget Sound deltas due to their fertile soil and flat topography. In most cases, landowners and local governments have constructed levees and tidegates around agricultural land to prevent flooding and saltwater intrusion.

3.4.2 Public Access and Recreation

Many recreation opportunities associated with the nearshore zone are dependent on access. The Washington State Public Trust Doctrine states that the waters of the State are a public resource for use and owned by the public for purposes of navigation, fishing, and recreation. While the doctrine provides for public use of waters regardless of tideland ownership, it does not require property owners to provide access to these areas. The Washington Shoreline Management Act of 1971 acknowledges the need for public access by including it, along with shoreline use and environmental protection, as overarching policies of the Act. Table 3-4 provides a summary of shoreline access in Washington State by general geographic area (WDOE 2009b).

Recreational opportunities associated with the nearshore zone range from passive (e.g., viewing the nearshore zone and its associated wildlife or sunbathing on a beach) to active including fishing, swimming, scuba diving, and boating. The Puget Sound area attracts $9.5 billion in travel spending annually, including 88,000 tourism-related jobs and $3 billion in income (WDOE 2008). Based on a 2001 wildlife viewing survey completed for the USFWS, approximately 208,000 U.S. residents (over the age of 16) travel to Washington State annually to view killer whales and other marine mammals. This estimate for 2001 shows Washington's whale watching industry generated approximately $18.4 million in sales and 205 jobs in counties adjacent to the coastal habitat of killer whales (Industrial Economics, Inc. 2006). According to the 2006 Outdoor Recreation Survey (Clearwater Research, Inc. 2007), 34% of Washington's 6.5 million residents engaged in beach combing, 31% swam or waded at marine beaches, 7% fished from shore, and

9% collected shellfish. All of these recreational opportunities bring many visitors to the area; nearly 80% of the state's revenue from tourism is generated in the Puget Sound area (Earth Economics 2008).

Table 3-4. Shoreline public access summary Source: WDOE 2009b

Shoreline Location	Miles	Percent of total statewide shoreline miles	Number of public access sites
Puget Sound Shore	591	17%	821
Outer Coast of Pacific Ocean	363	11%	152
Strait of Juan de Fuca	102	3%	66
Hood Canal	39	1%	74
Total Shoreline Public Access	*1,095*	*32%*	*1,113*

Sportfishing for salmon and other marine fish is a popular activity in Puget Sound; however, the decrease in the availability of some salmon species for sportfishing has been dramatic. Nonetheless, the activity remains popular; marine recreational anglers in Washington State spent an estimated $126 million in 2004 including fishing equipment expenditures, but this figure does not include trip-related expenditures, which can be hundreds of dollars per trip and employ many individuals as captains and crew (Southwick 2006). Of all the salmon caught in freshwaters of Washington, 57% were caught in rivers that drain into Puget Sound, and of all salmon caught in marine waters, 60% of these fish are from Puget Sound stocks (TCW Economics 2012).

Shellfishing around Puget Sound includes Dungeness crabs, clams, oysters, and spot shrimp. Non-tribal recreational crabbers have been taking an average of 1.4 million Dungeness crabs each year since 2000, and treaty-reserved tribal collections amount to roughly 4 million per year (WDFW 2012a); the Puget Sound contribution to these figures is 85% (TCW Economics 2008). Non-tribal clam harvesting within Puget Sound produced nearly 350,000 pounds of clams in 2006; recreational harvesters collected over 650,000 oysters as well (TCW Economics 2012). Most of the spot shrimp in Washington (78%) comes from South Puget Sound areas, caught by recreational harvesters.

Expenditures for these activities go toward equipment, boat launching, fuel, and bait among other goods and activities. Economic effects of recreational fishing and shellfishing have direct benefits to food and beverage suppliers and establishments, lodging, gas stations, sporting goods suppliers, equipment rental suppliers, and guide services. Recreational anglers spent an estimated $905 million in Washington State in 2006 on fishing equipment and trip-related expenditures; approximately half of the net economic value of this figure is associated with species that rely on the nearshore zone for some part of their life history (TCW Economics 2008).

3.4.3 Commercial Fisheries and Aquaculture

Commercial fishing and aquaculture are key industries in the Puget Sound economy. In 2007, approximately $3.9 billion, or 2.1 percent of Washington's overall revenue for the year, was generated from industries directly and indirectly associated with the commercial fisheries of Washington State. The industry includes businesses that harvest, distribute, and process finfish and shellfish products, as well as those that provide supplies and services to them. Puget Sound salmon, groundfish, Pacific herring, shellfish, and Dungeness crab are commercially harvested, processed, and distributed from multiple ports throughout the region. Commercial aquaculture includes the production of farmed clams, oysters, mussels, and geoducks.

Commercial fisheries for finfish in Washington State harvest a wide variety of species; key examples are salmon, rockfish, lingcod, sablefish, and halibut. Landings of commercially harvested fish statewide were valued at $272 million in 2010 (NMFS 2012); Puget Sound ports account for about 52% percent of Washington commercial fishery landings (TRG 2008). Fourteen of the 19 commercial fishing ports in Washington State are located in Puget Sound. The highest grossing ports are located in Bellingham Bay, Seattle, Anacortes, and Blaine. Other commercial fishing ports adding substantial economic value to their local economies are located in Neah Bay, La Conner, Everett, Tacoma, Olympia, and Shelton. Over the past three decades, the combined total harvest of tribal and non-tribal commercial fisheries has decreased by 60%, ranging from approximately 70 down to 30 million pounds harvested annually (Plummer pers. comm. 2009). Figure 3-2 illustrates the historical trends for commercial finfish and shellfish harvest in Puget Sound from 1981 through 2008.

Commercial harvest of shellfish such as oysters, clams, and mussels has been occurring in Puget Sound for over a hundred years, leading to a robust aquaculture industry that is one of the largest shellfish producing regions in the U.S. Shellfish aquaculture in Puget Sound has shown significant growth since the early 1980s, including an increase in geoduck production, a shellfish species that was virtually unknown outside the Pacific Northwest 40 years ago. Today, Puget Sound commercial harvesters sell 1.7 million pounds of this species each year, primarily in overseas markets bringing in $20 million in yearly state revenues (PCSGA 2012). Puget Sound's commercial aquaculture industry has been relatively stable over the past several years. The most recent data available are for 2009, when the total weight of all oysters, clams, mussels, and geoducks was nearly 75 million pounds, with a sales value of $107 million (PCSGA 2012).

Harvested fisheries and seafood products are destined for domestic as well as foreign markets, creating a commerce system with many beneficiaries. The industry contributes to seafood and fisheries processing and other sectors of the state economy such as marine technology and vessel maintenance and repair. Fishing vessels, processors, and related support businesses provide many jobs and substantial economic benefits to the regional economy. As reported earlier in this section, in 2007 approximately $3.9 billion, or 2.1 percent of Washington's overall earnings for

the year, was generated from industries directly and indirectly associated with commercial fisheries in Washington State (BEA 2010, as cited in Radtke 2011).

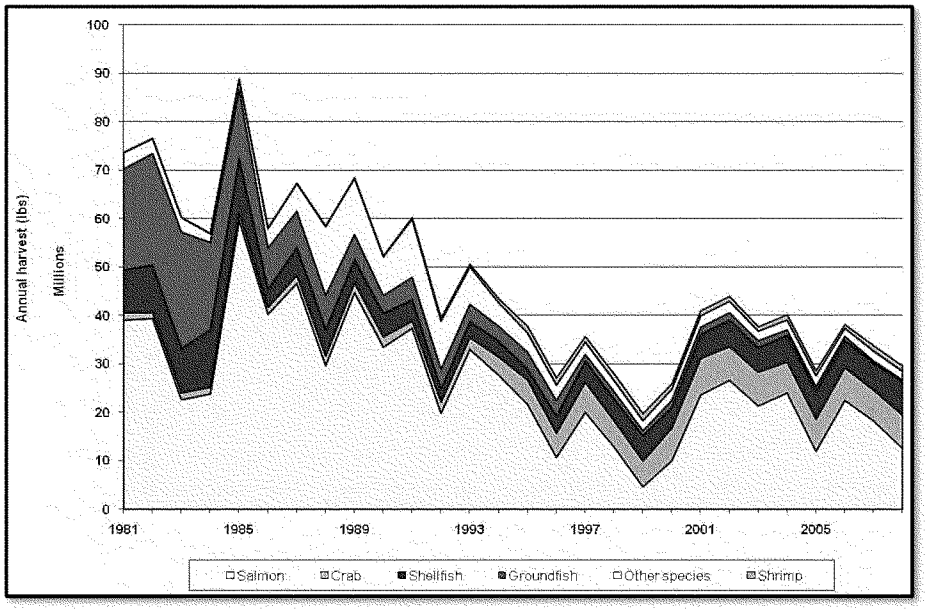


Figure 3-2. Puget Sound Commercial Fishery Harvest, 1981-2008 Source: Plummer (2009)

3.4.4 Transportation

The Puget Sound transportation system is a network of infrastructure moving people and goods within the region. In addition to the typical network of roads, highways, and railways, the system includes a fleet of vehicle and passenger ferries operated by the Washington State Department of Transportation. Puget Sound is home to the second largest U.S. harbor for container traffic, shipping over 62 million metric tons annually in recent years (WDOE 2008). The lucrative commerce industry located in Puget Sound has led to an expansive port and rail system.

Roadways within Puget Sound are commonly located along the shoreline to take advantage of the relatively flat and unobstructed terrain, avoiding the design challenges associated with hilly terrain. Roads along the shoreline are scenic and provide access to shoreline properties and public beach access points. By necessity, ferry terminals and international shipping port infrastructure are located in the nearshore zone. Terminals that allow for access to ferries and their associated vehicle holding areas (paved impervious surface) are located on wharves over the sub tidal and intertidal zones and extend into the adjacent upland area. The ports of Seattle, Tacoma, and Everett were built in historical river deltas to take advantage of flat real estate for

upland storage and the easy access to deep water that allows large vessels to reach the wharves, cranes, storage yards, and rail lines for nationwide distribution of goods and commodities. Each port includes the terminus of a rail line, and much like the region's roads, rail corridors follow along the shoreline for efficient use of a flat right-of-way. Long stretches of rail lines extend along the eastern Puget Sound shoreline from Everett to Seattle and Tacoma to Nisqually. Shoreline roads and rail lines have contributed a significant amount of the degradation of the shoreline through fill, armoring, and stabilization of the Puget Sound nearshore zone.

3.4.5 Public Safety

Public safety is a primary concern for any Federal water resources project. The following features may be included in the proposed action and may have relevance for public safety: levees, tide gates and culverts for flood risk management, shoreline armoring for erosion protection, roads for access of emergency and police vehicles, vehicle and railroad bridges, and public utility infrastructure. The proposed action contains ecosystem restoration features that must be designed to maintain public safety, for example, proposed projects would at a minimum maintain the existing level of flood risk management.

Restoration of nearshore habitat requires balancing improved estuarine flow conditions with the need to maintain road and railway access in and across the project, especially during emergencies and high water conditions. Public utilities such as phone lines, sewer, fiber optic cabling, electrical transmission lines, and pipelines frequently follow the linear corridors already occupied by roads, highways, and railroads. These corridors often cross streams, rivers, and estuaries to deliver services to cities, towns, and developments of all sizes. Ecosystem restoration features that enhance the flow of water must consider and design for continued railway and vehicle access as well as delivery of all public utility services.

Airports near wetlands need to minimize risks from birds and wildlife. The Federal Aviation Administration provides an advisory circular regarding land uses that attract "hazardous wildlife" on or near public-use airports (FAA 2007); it references a 2003 Memorandum of Agreement on this topic signed by the Corps and other Federal agencies. This circular covers considerations for airports near wetlands and other wildlife habitat. In addition, the Navy has their Bird/Animal Aircraft Strike Hazard (BASH) (U.S. Navy 2010) program, which describes a variety of measures that help minimize risk to aircraft from bird and animal strikes.

3.5 NEPA SCOPING RESULTS

As stated in the introduction to Chapter 2, certain resources were not raised as significant issues during the NEPA scoping process and therefore were not analyzed in detail as they related to potential impacts of the proposed action. Resources not carried forward for detailed analysis are sediment quality, air quality, aesthetic resources, environmental justice, public utilities, and airborne noise. The following sections provide a summary of the existing conditions of these topics and brief rationale for exclusion from detailed analysis.

3.5.1 Sediment Quality

Glacial retreat left a mix of substrate types around the Puget Sound nearshore zone, which include mixed sand, gravel, and cobbles on the beaches, and sandy and muddy sediments around the large, fertile river deltas. Relatively recent human activities in the adjacent watersheds have contributed some of the finer sediments to the substrates. The primary characteristic of sediments is the vast variability in grain size distribution.

No sediments in Puget Sound are free from the contamination typical of urbanized and industrialized waterfronts in the United States. Under the No-Action Alternative, these sediments in Nearshore Study-identified sites would likely remain in place and may release contaminants for an extended period, whereas under the proposed action alternatives, any contaminated sediments identified during design or construction would be addressed in accordance with applicable laws and regulations. The result of construction would not reduce the quality of any sediment. Project features shall be designed to minimize post-project erosion of any identified areas of contaminated sediment. Some sediment of agricultural value may be lost to the aquatic environment as natural ecosystem processes are restored to the nearshore zone, which include sedimentation and erosion processes. Other aspects of sediment quality such as presence of toxic substances and invasive species seed sources are analyzed in their respective chapters in this document. The proposed ecosystem restoration activities would be expected to improve sediment quality at the site locations and would have no effect toward degradation of sediment quality; therefore, the proposed action would have no significant impact to sediment quality.

3.5.2 Air Quality

Under the provisions of the Clean Air Act (CAA), the EPA has established National Ambient Air Quality Standards (NAAQS). The standards specify maximum concentrations for carbon monoxide, particulate matter smaller than 10 micrometers, particulate matter smaller than 2.5 micrometers, ozone, sulfur dioxide, lead, and nitrogen dioxide. The EPA has published a list of all geographic areas with their NAAQS compliance status; for each NAAQS pollutant, each area is considered an "attainment" or "non-attainment" area. In a non-attainment area, the air pollutant concentration exceeds the NAAQS for one or more of these pollutants.

The proposed action may have temporary minor adverse impacts on highly localized air quality at the construction sites; construction may take months to years depending on the site. For all sites, best management practices would keep fugitive dust under control during land clearing activities. Heavy equipment would produce hydrocarbons in exhaust emissions although the incremental contribution would be extremely small compared to all sources of exhaust emissions in the region. Construction contractors would be required to keep all equipment in good working order to minimize emissions. Exhaust emissions would not be at a level that puts human health at risk, and the restoration sites would not have any permanent source of air pollutant emissions. A long-term effect of this ecosystem restoration project is that the increased area of vegetated

wetlands could aid in removal of carbon dioxide and some other gaseous air pollutants. For these reasons, this project would have no significant impact to air quality in the Puget Sound area.

3.5.3 Aesthetic Resources

The visual character of the Puget Sound nearshore zone ranges from nearly pristine wilderness shorelines, to quaint waterfront towns such as Port Gamble and Port Townsend, to modern cityscapes like Tacoma and Seattle. While aesthetic value of a landscape can be highly subjective and vary widely depending on the viewer, the standard used for analysis for this project relies on values stated in the Washington State Shoreline Management Act (RCW 90.58.020). This Act protects the public interests of the natural character of the shoreline, resources and ecology of the shoreline, and public access and recreational opportunities.

The proposed project sites would have a temporary reduction of aesthetic quality for the duration of construction, which may take months to years per site. The long-term change, however, would be a return of the shoreline to a more natural configuration resembling the pre-settlement wilderness conditions. None of the stated values of the Shoreline Management Act would be precluded or degraded. The result of the proposed action would not degrade natural viewsheds, conflict with local guidelines or goals related to visual quality, reduce sunlight availability in residential areas, or obstruct views of valued resources. Therefore, the proposed action would have no significant impact on the visual quality and aesthetic resources in the Puget Sound area.

3.5.4 Environmental Justice

The purpose of Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" is to protect minority and low-income populations from disproportionately high and adverse human health or environmental effects from government programs, policies, and activities. Only one of the proposed sites is located in proximity to a qualifying stakeholder community, the Lummi Nation. The Lummi Nation has been a strong proponent of the Nearshore Study since the beginning of the General Investigation and has no opposition to an ecosystem restoration site proposed in proximity to their tribal lands and interests. The nature of the proposed action is such that it would have no adverse human health or environmental effects and would in fact benefit the stakeholder community identified. Therefore, the proposed action would have no significant impact on environmental justice or any identified minority or low-income population.

3.5.5 Public Utilities

Public utilities have rights-of-way in the Puget Sound nearshore zone that include natural gas pipelines, water supply pipelines, sanitary sewer collection lines, and phone, cable, and electric lines. In general, public utility services at the proposed restoration sites would be avoided, modified, relocated, upgraded, or abandoned in accordance with applicable regulations. Specific impacts to utility lines located within the project sites would be evaluated during the design

phase and mitigated during construction. In most cases, the public utility infrastructure would benefit from upgrades and replacement, or relocation that reduces risk of inundation in predicted sea level change scenarios. There would be no or very minimal disruptions to services during construction and no long-term change to availability of the utilities; therefore, this project would have no significant impact on public utilities in the Puget Sound nearshore zone.

3.5.6 Airborne Noise

Urbanization and industrial development have affected the soundscape of many areas around Puget Sound. Anthropogenic noise reflected off hard surfaces such as buildings and pavement can affect the behavior of certain species that use sound for communication (Dowling et al. 2011). Typical noise sources around the Puget Sound nearshore zone consist of motorized traffic on shoreline roads; train traffic on the rail lines along the eastern shoreline of Puget Sound; aircraft noise from military, commercial, and private airplanes; and heavy industry at the major ports and developed waterfronts.

Airborne sound sources that would occur during restoration construction activities would mainly be from large vehicle traffic on local roads, and construction machinery operating at the sites. Machinery noise at the project sites as well as haul truck traffic during construction would cause unusually high noise levels at residences and businesses near the site and near roads that access the site. This engine noise, however, would only occur during regular working hours, and would only endure for the construction period. Most of the proposed sites are located away from residential areas, and the effects would certainly not be Sound-wide. Therefore, the proposed action would have no significant impact on airborne noise in the Puget Sound nearshore zone.

3.6 FUTURE WITHOUT-PROJECT CONDITIONS

This section describes the Study team's approach to assessing the most likely future conditions in Puget Sound, and summarizes the findings. Characterizing expected future conditions informs strategic water resources planning by providing a baseline against which to evaluate the effects of proposed alternatives. While the Study team has collected and analyzed information that suggests Sound-wide trends of increased degradation, it is not possible to accurately predict the degree of future degradation of nearshore ecosystem processes and functions at the scale of a particular restoration action. The Corps defines the period of analysis as spanning 50 years beyond when benefits would commence once an authorized project is implemented. The Nearshore Study period of analysis is from 2015 to 2065. While the "future" for this project has been defined at 2065, future conditions are reported in the years for which resource documents report their data. The Nearshore Study sites are stand-alone project proposals with a footprint limited to only that area where no other restoration is planned as of release of the report. Some sites have completed projects adjacent to the Nearshore Study sites, but not within the proposed footprints. The Nearshore Study sites are complementary to, but independent from, any adjacent restoration sites.

3.6.1 Nearshore Ecosystem Processes

Ecosystem process degradation was measured using the process evaluation framework summarized in section 1.8 and described in detail in the Strategic Needs Assessment report (Schlenger et al. 2011a). The framework provides a method for quantifying the degradation of nearshore ecosystem processes associated with nearshore stressors. These results were used to characterize existing conditions and as an input into the ecosystem benefit model used for the cost-effectiveness analyses described in Chapter 4. To help depict future without-project conditions and to inform the Study team's understanding of where Nearshore Study objectives could best be achieved, authors completed an addendum to the Strategic Needs Assessment using development patterns forecasted as part of a future risk assessment conducted by Oregon State University researchers (Bolte and Vache 2010). This report describes the application of scenario-forecasting computer model called ENVISION. It is titled "Envisioning Puget Sound Alternative Futures" and is incorporated by reference (available online at *www.pugetsoundnearshore.org*.)

3.6.1.1 *Future Risk Assessment*

The Study team recognizes that projected population growth and associated development within the Puget Sound region pose a potential risk to the success of recommended restoration actions. To investigate this risk, the Study team forecasted regional development patterns associated with expected population growth. Future population estimates were computed based on a medium-growth projection from the Washington State Office of Financial Management (OFM) through 2030. By extrapolation of the OFM annual growth estimates, the Puget Sound region's population is expected to grow to 9.1 million residents by 2065.

To forecast land development patterns in Puget Sound, the Study team applied the scenario-forecasting computer model, ENVISION as mentioned above. Land development scenarios account for potential changes in land use policy and associated development patterns. See Appendix F for further information on the use of ENVISION.

3.6.1.2 *Projected Future Nearshore Ecosystem Process Degradation*

To forecast degradation of nearshore processes in the study area, the Bolte and Vache (2010) Status Quo scenario projections were used for the analyses in this section. These projections were applied to the same process evaluation framework as was used to evaluate existing conditions. Due to the limitations of the input data and the technology in supporting the modeling of spatially explicit projections for all of the stressors, Bolte and Vache (2010) provided projections on the distribution of a subset of the stressors. As a result, the assessment of forecasted process degradation used projections of future distributions of three stressors, and relied on present distribution data for the other nine stressors used for nearshore ecosystem process degradation calculations. The assumptions used in the forecast of process degradation and an explanation of the justification for accepting each assumption are detailed in Appendix F.

As reported in an addendum to the strategic needs assessment report (Schlenger et al. 2011b), many portions of the Sound are expected to encounter further degradation of nearshore ecosystem processes (Figure 3-3) well beyond current conditions (Figure 1-6). The evaluation suggests that the most concentrated increase of areas entering the more-degraded or most-degraded categories will be along the western shoreline of the South Central Puget Sound sub-basin, in an area that includes Bainbridge Island. As a result, much of the central portion of Puget Sound, which forms the only connection between South Puget Sound and the ocean, will be among the most degraded areas in the Sound. In fact, the forecast shows 55% of the South Central Puget Sound shoreline length will fall into the most-degraded category.

The most widespread increases in degradation among the currently less-degraded or least-degraded areas in Puget Sound are forecasted to occur in three sub-basins: the South Puget Sound, San Juan Islands, and Georgia Strait sub-basins. In addition, as suggested by the land use/land cover projections presented the in the Future Risk Assessment (Bolte and Vache 2010), process degradation will begin to appear in more remote portions of Puget Sound.

Another important factor to consider is that without restoration, the present stressors will still be in place in the year 2065. As such, the natural ecosystem setting and the processes that create and maintain it will have been impaired and will continue degrading for another 50 years. For example, for nearshore ecosystem processes related to sediment supply, transport, and accretion, the prolonged degraded condition can lead to significant lowering of the beach profile and coarsening of the shoreline substrate (i.e., much less sand and much more cobble). In addition, since these processes are vital to creating and maintaining barrier beach features such as spits, locations throughout Puget Sound could see some loss of these landforms and the embayments they protect. The reduced availability of fine-grained sediment to maintain features and functions would affect a large portion of the remainder of these landforms.

Figure 3-3 shows the projected future degradation of nearshore ecosystem processes throughout Puget Sound and this can be compared to Figure 1-6.

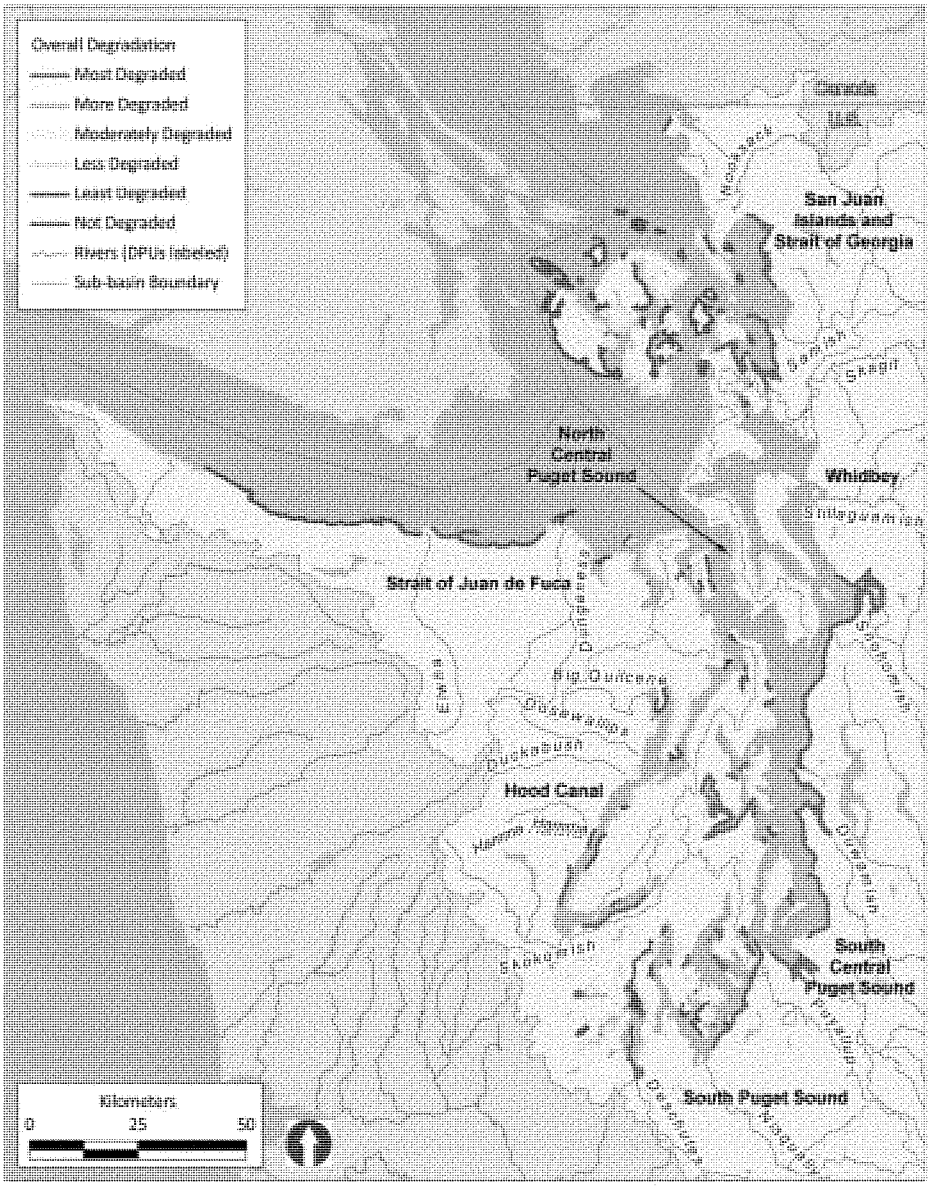


Figure 3-3. Projected Overall Process Degradation by Process Unit in the Year 2060

3.6.2 Biological Environment: Nearshore Zone Functions

Shoreline and watershed development are forecasted to continue expanding and will degrade the nearshore ecosystem processes that create and maintain Puget Sound ecosystems. The expanded footprint of degraded areas, combined with climate change and sea-level change, will further imperil the ecosystems that support diverse biological communities that inhabit or otherwise depend on Puget Sound. While evidence of the implications of this ecosystem degradation is apparent in the declines of many biological communities to date, forecasts show increases in degradation will greatly worsen the species declines. As summarized below, the declining conditions of Puget Sound ecosystems are expected to influence declines across all levels of the food web, from lower trophic levels like invertebrates to top predators such as killer whales. Forecasts show that without significant ecosystem restoration, species populations that are low now will move closer to extinction and additional species may become threatened.

3.6.2.1 *Vegetation*

Marine Submerged

Stressors that affect submerged aquatic vegetation (SAV) include those that affect the amount of light available to the plant, the direct and indirect effect of high or low nutrient levels, toxic substances, and physical disturbances (Mumford 2007). Decreased light levels often occur from an increase in suspended sediments (i.e., turbidity) or because of overwater structures such as piers, docks, and moored boats. Sedimentation from upland runoff or re-suspension can prevent kelp spores or zygotes from attaching and cause injury from smothering and light blockage (Schiel et al. 2006, Mumford 2007). Degraded water quality can cause kelp losses as well. The ENVISION model results show shoreline development, deforestation, and impervious surfaces increasing through 2060. Each of these increases could decrease water quality and increase turbidity to the degree that kelp populations will decline. The predicted construction of marinas and other over-water structures will likely contribute to the (potential) decline of kelp by 2065. Increased ocean temperatures associated with climate change could decrease kelp abundance as well, particularly in embayments already experiencing near-lethal temperatures.

A wide variety of factors adversely influence eelgrass meadows including dredging, marinas, increased storm intensity attributable to climate change, and a variety of human activities that reduce water quality and decrease light reaching plants. Water quality often deteriorates due to coastal development, land-based practices, dredging, and eutrophication. The decline in water quality from projected population growth and its associated land use practices paired with additional shading from docks and marinas may lead to declines in eelgrass bed size and abundance throughout Puget Sound.

Ulvoids (a type of green algae) tend to dominate nearshore algal blooms, which may result from nutrient loading and non-point source pollution. These blooms have the ability to deplete oxygen concentration in a process referred to as eutrophication, alter the structure and diversity of

marine communities, and reduce eelgrass shoot density and fragment eelgrass meadows. Additions of shoreline development and impervious surfaces will likely contribute to an increase in the abundance of ulvoids due to nutrient loading, which could exacerbate hypoxia events as the ulvoids decay and consume oxygen. Water temperatures higher than 64 °F promote harmful algal blooms and since water temperatures in Puget Sound are expected to increase by 10 °F by 2100 (Climate Impacts Group 2009), there will likely be earlier and longer lasting blooms (Pearson et al. 2011b).

Climate change and sea-level change are likely to impact eelgrass meadows, but the exact effects are uncertain. Climate change stressors are related to water quality and light availability (sea level change and temperature rise, suspended sediment, nutrient-driven harmful algal blooms, contaminants, disease, and freshwater input) and physical changes from shoreline armoring. The resulting increased depth and light attenuation from sea level change may contribute to vulnerability of eelgrass and/or result in eelgrass decline at the lower edges of beds. Warmer water directly affects the productivity and respiration rates of eelgrass with extended periods of high temperatures reducing eelgrass growth and survival, which can affect large areas of the Sound. In places where the water warms substantially in the summer (e.g., poorly flushed shallow bays), small increases in temperature would cause loss of plants. In the case of climate change driven sea temperature increases, the reversibility would be low (Thom et al. 2011).

Increased frequency of El Niño conditions are an anticipated implication of climate change, and are known to affect growth patterns of SAV. El Niño conditions are associated with increased storminess that can stress eelgrass. Increased precipitation resulting from climate change will likely compound with the forecasted increase in deforestation, development, and impervious surfaces to further degrade water quality (e.g., increased suspended sediment and harmful algal blooms) with ensuing decline in eelgrass meadows. As sea level changes and beach profiles migrate landward, eelgrass meadows will recede inland. Armored shorelines constrain the shallow water edge of the eelgrass beds, which will not be able to move landward. Additional impacts to species distribution of all SAV types are likely to result from climate change, which may alter the competition between eelgrass species and algal populations (Short 1999).

Wetlands

Estimates of wetland loss over the past 150 years in Washington range from 20 to 39%, while other estimates are as high as 50% statewide and 70 to 100% in highly urbanized areas (Lane and Taylor 1997). Nearshore wetland loss and degradation in Puget Sound are most commonly the result of urban expansion, forestry, and agricultural practices (Canning and Stevens 1989; WDOE 1992a, b). Estimates of continuing wetland loss range from 700 to 2,000 acres per year with additional and significant degradation to remaining wetlands (WDOE 1992a, b); however, these estimates are statewide and not specific to the Puget Sound nearshore zone. Given previous trends of wetland loss in the nation, one could deduce that those trends would continue for Puget Sound. A few causes of continued loss, despite a national policy of no net loss, are that some

wetlands are exempt from regulation based on small size or isolation, and required buffer widths are too small to provide protection. Ultimately, projections of wetland abundance in the nearshore zone depend on a variety of factors including land development and zoning, regulatory permitting and enforcement, mitigation requirements, sea-level change, and climate change.

Estuarine salt marshes and other wetlands potentially affected by sea-level change face new risks related to climate change. Modest sea-level change during the 20th century does not appear to have adversely affected the majority of the region's salt marshes. These systems were able to keep pace through accretion (accumulation of sediments), generally captured by vegetation structure (Thom 1992). Increasing rates of sea-level change may lead to substantial loss of salt marsh habitat, especially in areas that are subsiding and/or where sediment supply is reduced or where upland migration of marshes is prevented by shoreline armoring, coastal development, or natural bluffs. Projected changes in water temperature, water salinity, and soil salinity could change the mix of plant species in salt marshes and the viability of invertebrates that play a key role in the health of salt marsh systems (Snover et al. 2005). Furthermore, many freshwater marshes adjacent to marine waters are likely to convert to salt marshes or to transitional marshes that experience frequent saltwater inundation (NWF 2007). If coastal development occurs or if shoreline armoring continues to be used as a countermeasure for sea level change, the new salt marshes will also, in turn, disappear due to subsidence or lack of sediment supply.

Riparian Areas

Results of ENVISION modeling show loss of an additional 1,350 square miles (3,500 km^2) of forest due to new development in Puget Sound by 2060. Less than one percent of the forest loss is expected to occur within 200 feet of the shoreline. Shrub/scrub will likely see the greatest loss as a percentage of total natural area. The relative abundance of other terrestrial vegetation types appears in Table 3-5 (note these figures are for the Puget Sound watershed, not just shoreline).

Table 3-5. Projected Land Cover Distributions in 2060 (Source: Bolte and Vache 2010)

Natural land Cover Type	2010 (%)	2010 (km^2)	2060* (%)	2060 (km^2)	Change (km^2)
Barren land	3%	1,011.2	1%	920.1	-91.1
Deciduous forest	3%	945.7	2%	756.1	-189.6
Emergent Herb Wetlands	1%	329.5	1%	321.3	-8.3
Evergreen forest	62%	20,061.5	31%	17,512.8	-2,548.7
Herbaceous	3%	1,136.3	2%	921.7	-214.5
Mixed forest	9%	3,011.3	5%	2,491.8	-519.5
Open Water	2%	498.1	1%	472.7	-25.4
Snow/Ice	1%	380.2	1%	380.2	0.0
Shrub/Scrub	14%	4,499.7	4%	3,897.2	-602.4
Woody Wetlands	2%	637.0	1%	606.9	-30.1

*By 2060, 51% of the natural land cover types that occur in 2010 will have changed to some type of developed, non-natural land cover.

The influences of climate change and sea-level change will result in additional changes to the structure and composition of terrestrial vegetation throughout the region. Potential forest impacts are tied to changes in summer and winter temperature and precipitation, snow pack duration, and regional hydrology (Littell and Binder 2007). Sea-level change will result in the inland migration of the shoreline and halophytic vegetation assemblages will shift landward. Salt marshes are anticipated to expand at the expense of freshwater wetlands as saltwater inundates them. Exacerbated bluff and bank erosion associated with sea-level change and precipitation, stream flows, and flooding will reduce bluff and bank vegetation. Deciduous forest may increase in abundance along these disturbed areas, which might previously have been predominantly coniferous forest. The increase in disturbance combined with changes in climate zones could result in rapid shifts in species ranges (or in genetic variability within species). Increased risk of wildfires, vulnerability to insects, and a decrease in growth and regeneration are anticipated in drier, lower elevations (Littell and Binder 2007).

Forest Aggregation Index

According to the Regional Geographic Initiative, conducted by Urban Ecology Research Laboratory at the University of Washington from 1991 to 2001, most sub-watersheds of the Puget Sound area saw a significant decline in their forest aggregation index (an indicator of forest fragmentation). According to the Cascade Land Conservancy, the business-as-usual trends for this region will cause increased fragmentation. According to the Rural Forest Initiative, western Washington has been losing forestland at increasing rates in the last two decades.

3.6.2.2 *Invertebrate Assemblages*

Several invertebrate species are in decline due to loss or degradation of habitat. At least two species, Olympia oyster and Northern abalone, have undergone long-term declines with little evidence of potential for recovery. All native invertebrate populations are affected by habitat loss or pollution due to human development (Dethier 2006). Continued declines are anticipated with further habitat encroachment and the effects of development such as pollution. Changes in water quality conditions from increased temperature, ocean acidification, and more frequent episodes of low dissolved oxygen will exacerbate existing stressors on most invertebrate assemblages (Newton et al. 2008). Select species that have adapted to anthropogenic changes to the shoreline may flourish, potentially to the detriment of more sensitive species. The further transition of nearshore invertebrate communities to more tolerant species is anticipated.

3.6.2.3 *Fish Communities*

Demersal/Benthic Fish

Some groups of demersal/benthic fish, such as rockfish, are in depressed or critical condition, while others like English sole and Pacific halibut have seen increases (PSP 2009). While the overall trend of demersal/benthic fish population could remain stable, further declines are

expected for long-lived and late maturing fishes, such as certain species of rockfish. Such species have been assessed as vulnerable to extinction warranting protection under the ESA.

Forage Fish

Pacific herring are the only forage fish species that has been monitored comprehensively in Puget Sound in the last 20 years. For the 2007-08 period, fewer than half (47%) of local herring stocks are classified as healthy or moderately healthy. This is the lowest percentage of individual stocks meeting these criteria since development of the stock status summary in 1994 (Stick and Lindquist 2009). Moreover, additional impacts could result from sea-level change potentially inundating intertidal spawning grounds on shoreline beaches, and projected development trends that could cause further habitat loss within the region. Sea-level change is likely to cause substantial loss of surf smelt spawning habitat on beaches with armored shorelines because armoring prevents beach migration inland (Griggs et al. 1994), thereby reducing the area of beach with elevations preferred for spawning. Estimates of sea-level change suggest that on beaches with armored shoreline, substantial surf smelt spawning habitat might be lost in the next few decades and most spawning habitat might be lost by 2100 (Krueger et al. 2010).

Anadromous Fish

Many anadromous fish species are in decline due to loss or degradation of habitat. Between the 1992 and 2002 salmon population inventories, the number of salmon stocks that were listed as depressed or critical increased by one-third (WDFW 1993 and 2002). Projections show it is likely that populations of anadromous fish, particularly salmonids, will continue to decline due to sub-optimal habitat for rearing and spawning that has been altered by armoring, filling, and diking of the shoreline, as well as development in the upper watersheds. The impacts of climate change will likely exacerbate degraded habitat conditions in nearshore areas and may affect populations of anadromous salmonids. For example, an 18- to 32-inch sea-level change in the Skagit Delta may reduce the rearing capacity in marshes for juvenile Chinook salmon by an estimated 211,000 and 530,000 fish respectively, which are substantial percentages of this population (Hood 2005). The projected changes are also likely to affect Coho and pink salmon, cutthroat trout, and bull trout, which depend on marshes and other nearshore habitats for parts of their life cycle (Williams and Thom 2001). If recovery efforts in the region are successful, they may eventually diminish these losses, but many other variables could influence population trends of salmonids including environmental contaminants, oceanic conditions, and other aspects of climate change such as increased water temperature and changes in stream flows. Population trends for certain anadromous species, such as green and white sturgeon, will depend more heavily on conditions outside of Puget Sound.

3.6.2.4 *Birds*

Species with significant declines in abundance included red-throated loon, numerous grebe species, canvasback, scaup, black scoter, common goldeneye, ruddy duck, Bonaparte's gull, glaucous-winged gull, common murre, and two murrelet species. Trends between 1992 and 1999

indicate a reduction of 58% for all three Puget Sound scoter populations. Great blue heron populations show an overall trend that indicates a slight to moderate increase; however, significant changes in colony dynamics were apparent as birds shifted from engagement with numerous small colonies to a consolidation of herons into fewer larger colonies. This trend is disturbing in that it increases the risk of large population loss through a single catastrophic event. Other species such as the common loon, double-crested and pelagic cormorants, bald eagle, and most notably the Canada goose showed significant increases (Bower 2009). Due to the likely continued loss of habitat and prey species, such as forage fish and juvenile salmonids, continued decline of many Puget Sound bird species is likely. Species like cormorants, crows, and gulls that have successfully adapted to development within the region may increase and may out-compete species that are more sensitive.

3.6.2.5 *Mammals*

Populations of terrestrial mammals that use the Puget Sound nearshore zone, such as raccoons and deer, will likely remain stable largely because they have adapted to the human environment. Likewise, harbor seal and California sea lion populations may remain stable due to their similar adaptability. However, declines of the more sensitive marine mammal species like killer whales are probable as they continue to be limited by prey abundance and environmental contaminants.

3.6.2.6 *Invasive and Introduced Species*

Human modification of shorelines, including marina and shoreline development, can increase the likelihood of spread of invasive species either by way of additional boat traffic or the opportunity for colonization by invasive species, which are often more tolerant of disturbance than native species. Increases in the densities and diversity of exotic species populations are anticipated, given existing conditions and trends.

3.6.2.7 *Rare, Threatened, and Endangered Species*

The future conditions of rare, threatened, and endangered species in Puget Sound depend on a variety of factors including habitat loss, climate change, environmental contaminants, and harvest and poaching, as well as whether or not there is a recovery plan and how well it is implemented. Species with population declines that are tied to habitat loss, such as salmonids, may recover to some extent due to habitat restoration efforts throughout Puget Sound. Marine mammal species that are adversely affected by environmental contaminants, such as Southern Resident killer whales, have more uncertainty associated with forecasts. Species that are vulnerable to fishing pressure may recover if fishing and poaching are halted (as is the case with some of the listed rockfish species). Acidification of Puget Sound marine waters will affect the persistence of shellfish and other calcifer species. Other species' populations are dependent on conditions outside of Puget Sound. Below are expected trends for Puget Sound populations of ESA-listed species. As stated above, a variety of factors will influence these trends, not just the physical condition of the Puget Sound shoreline.

Southern Resident Killer Whale (Orca)

The 2004 NMFS Status Review of the Southern Resident killer whales presented a population viability analysis. The most optimistic model (based on data from the last 30 years) predicted a relatively low extinction risk of less than 0.1 to 3% in 100 years and 2 to 42% in 300 years. However, the most pessimistic model (based on data from the last 10 years) predicted an extinction risk of 6 to 19% in 100 years and 68 to 94% in 300 years. When modeled to a quasi-extinction rate (fewer than 10 males or females) instead of actual extinction (less than one male or female), the model predicted a risk of extinction of 40 to 67% in 100 years and 76 to 98% in 300 years. The Southern Resident killer whale's dependence on salmon and the persistence of bioaccumulating environmental contaminants make significant population declines likely.

Sea Otter

A survey from 2008 indicates that sea otter populations have increased moderately along the Washington Coast with a count of approximately 1,073 otters. Populations reintroduced on the western side of Vancouver Island are also increasing and expanding their range within British Columbia. If kelp beds along the San Juan Islands and Strait of Juan de Fuca remain unaltered, this sea otter population may continue to increase. However, the predicted loss of kelp habitat and declining shellfish populations may keep the Puget Sound sea otter population low.

Hood Canal Summer Chum

NMFS concluded that the Hood Canal summer-run chum Evolutionarily Significant Unit (ESU) is in danger of extinction due to degradation of habitat, harvests, and low water flows in the Strait of Juan de Fuca and Hood Canal watershed (Johnson et al. 1997). Of the original 18 spawning aggregations, only 10 are extant. The overall abundance trend over the past 40 years is positive for natural origin spawners in the Strait of Fuca populations, but negative in the Hood Canal populations (Ford et al. 2010). Declines are possible given the latest population trends and continued loss of habitat in Hood Canal. Certain smaller stocks in decline may lead to regional extinction of non-hatchery populations. Populations in Strait of Juan de Fuca may continue to increase given dam removal and restoration efforts.

Puget Sound Chinook Salmon

Nine of 31 populations of Chinook salmon within the Puget Sound ESU are classified as extinct and eight of those were early run populations. Most of the remaining 22 Chinook populations are summer or fall runs with larger populations often supplemented through hatchery fish (Shared Strategy 2007). The 2005-2009 geometric mean of natural spawners ranges from 81 (Mid-Hood canal population) to 10,345 (upper Skagit population); most populations that contain natural spawners number in the high hundreds. Many populations have either declined or maintained numbers of wild fish over the past 30 to 40 years. The overall trend during this period for natural origin spawners in Puget Sound has declined, where 2009 showed the lowest returns since 1997 (Ford et al. 2010). This indicates a significant loss of genetic diversity. A continued decline in non-hatchery Chinook is anticipated given habitat loss trends; these declines will likely lead to

extinction in basins that produce runs with fewer than 200 adults unless substantial habitat restoration occurs in the near future.

Puget Sound/Strait of Georgia Coho

Puget Sound/Strait of Georgia Coho salmon populations are stable; however, it is difficult to tell native stocks from hatchery stocks (Weitkamp et al. 1995). It is likely that native origin Coho will continue to decline in the Puget Sound basin due to decreases in genetic diversity via inter-breeding with hatchery origin fish, as well as factors like habitat loss and pollution that affect all salmonids in the region.

Puget Sound Bull Trout

Of all the bull trout sub-population areas in Puget Sound, only the Skokomish area, which is thought to be the most depressed core area within the Olympic Peninsula management unit, has abundance data and trends based on monitoring. The species status in this core area is depressed with fewer than 60 adults documented in the South Fork Skokomish and approximately 100 adults documented in the North Fork Skokomish (Shared Strategy 2007). Given current trends of habitat loss and fragmentation, fisheries managers expect significant declines within the Puget Sound region and even extinction within the most depressed basins such as the Skokomish. Increasing water temperatures and changes in hydrology associated with climate change will impact bull trout disproportionately as it is the most temperature-sensitive species in Washington. Increased marine water temperatures will restrict the distribution of bull trout in nearshore areas while decreased snowpack and higher temperatures in freshwater will limit spawning and rearing areas in all watersheds.

Puget Sound Steelhead

Population trends reported in 2007 indicated significantly declining abundance in natural escapement for the Puget Sound ESU (NMFS 2007). All but a few demographically independent populations of steelhead in Puget Sound are declining. Redd counts are declining 3 to 10% annually. From 2005-2009 the geometric mean of winter-run steelhead has been fewer than 250 fish annually for eight of the 15 populations evaluated. The extinction risk for most populations in the next 100 years is estimated to be moderate to high (Ford et al. 2010). NMFS concluded that substantially declining abundance and low productivity as well as a moderate loss of diversity and spatial structure indicate that steelhead are "likely to become at risk of extinction" in the foreseeable future (Hard et al. 2007). Thus, continued declines of steelhead are anticipated given habitat conditions and population trends.

Green Sturgeon

NMFS concluded that small population sizes, water temperature changes, harvest losses, loss of spawning habitat in areas outside of Puget Sound, predation by exotic species, and pollution are having a deleterious effect on the Southern DPS of green sturgeon. These populations are "likely to become extinct" in the foreseeable future (NMFS 2006).

Rockfish
NMFS estimated a 3% per year declining trend in the overall abundance of rockfish. Bocaccio is believed to be at high risk of extinction, and yelloweye and canary rockfish are rated at moderate risk of extinction (NMFS 2009b). Given continued trends, further declines in these species are expected due to their late-maturing nature and low reproductive success in any given year.

Eulachon
NMFS found that even with little monitoring of eulachon, almost all data available for the species indicate an abrupt decline. Their assessment returned a moderate risk of extinction within the southern DPS of eulachon. The continued loss of habitat, largely outside of Puget Sound, and likely overuse of the species as sturgeon bait will likely cause further declines.

Marbled Murrelet
Modeling indicates annual declines of 4 to 7% (Beissinger and Nur 1997 from Huff et al. 2006) with a 16% probability of extinction in 100 years within California and Oregon and only 45 birds remaining in Washington (Huff et al. 2006). Estimates based on four years (2000 to 2003) of at-sea monitoring indicate no declines and even moderate increases in densities within Puget Sound. However, for the entire Northwest Forest Plan study area (including Washington, Oregon, and California), the authors anticipate being able to estimate a 5% annual decline with 80% power after seven years of data collection and modeling (Huff et al. 2006). Declines in marbled murrelets can be expected due to declining prey abundance (forage fish) and development in the upper watersheds where they nest. If a catastrophic event occurred, steeper declines and possible extinction within the region is conceivable.

Northern Abalone
Abalone in the San Juan archipelago declined by 77% between 1992 and 2006, and resulting densities were well below the threshold required for successful reproduction (Rothaus et al. 2008). Growth trajectory models in Canada suggest continued abalone declines in northern British Columbia (Zhang et al. 2007); given the documented Allee effect for Washington populations, this trend is likely transferable to Puget Sound populations (Babcock and Keesing 1999). Continued declines after fishery closures indicate a lack of recovery from past overharvesting. The fact that this continued decline is in some cases reaching levels below a successful reproduction threshold indicates the likely extinction of abalone populations within the Puget Sound basin in the near future. Climate change effects from increased acidification will decrease calcification rates and could compromise the survival of abalone and other organisms.

Olympia Oysters
Given the status quo scenario leading to continued degraded water quality, and lack of oyster reef habitat for larval settlement, Olympia oyster populations are not expected to increase. Restoration efforts may result in temporary holds in population numbers, but without significant changes to water quality, they will likely not last. Ocean acidification has been implicated as a

possible cause of recent large die-offs of cultured larval oysters, and will be an additional constraint to recovery efforts.

California Buttercup, Sharpfruited Peppergrass, and Golden Paintbrush
If the predicted rate of development and disturbance of the shoreline continues in areas where these species occur or could occur, then the likelihood of extirpation will increase.

3.6.3 Cultural Resources

Cultural resources within the Puget Sound nearshore zone will continue to be subject to both natural and human-made processes. Some natural processes negatively affect cultural resources through erosion, rising tides, landslides, or severe storms and less severe natural processes have little to no effect on cultural resources in the study area. Human-made processes such as shoreline development can have negative effects by destroying known and unknown cultural resources. Adverse effects from humans would likely be mitigated if the process is subject to Section 106 of the NHPA.

3.6.4 Socio-Economic Characteristics

Population growth and associated land development are key drivers shaping the future of Puget Sound. While development is also influenced by the economy, people will continue to build homes along the shore, conduct maritime activities, build roads and infrastructure, recreate, and consume food from the nearshore zone. Land and water use, release of pollutants, shoreline modifications, and other effects of population increase will be major drivers of ecosystem change, particularly without significant ecosystem restoration activities.

The human population in the Puget Sound Basin has increased rapidly over the last two decades. In 2005, approximately 4.4 million people inhabited the Puget Sound Basin, a 25% increase from 1991, with an average annual growth rate of 1.28%. The OFM forecasts population growth by looking at economic trends, migration, and natural growth (fertility and mortality). The Puget Sound population is expected to grow to 9.1 million residents by 2065, which is expected to lead to an expansion of developed areas in the Nearshore Study Area. The ways in which this development occurs to accommodate the forecasted growth will be a key driver affecting the future condition of Puget Sound.

3.6.4.1 *Shoreline Ownership*

Washington State shorelines and tidelands are a patchwork of public and private ownership. Today, an estimated 60 to 70% of Washington's tidelands are in private hands. Shoreline and tideland ownership patterns are not expected to change significantly from existing conditions. No forthcoming laws are anticipated to affect shoreline and tideland ownership. Therefore, it is expected that the current mix of private and state-owned tidelands will persist, and land development will occur according to predictions from the ENVISION analysis.

3.6.4.2 *Public Access and Recreation*

Given the largely private ownership of shoreline, public access is expected to remain similar to current conditions. Public access is recognized as an important component of shoreline activities as directed by the Shoreline Management Act, which strives to balance responsible shoreline development with environmental protection and public access (WDOE 2009c). The Interagency Committee for Outdoor Recreation (IAC) notes that projecting recreation participation into the future is at best a problematic exercise because participation in various outdoor activities is affected by a wide array of factors, including changes in population, available sites and infrastructure, lifestyles, economics, technology, and the politics of land use (IAC 2003). Nevertheless, the IAC used the best data available to forecast participation in outdoor recreation activities in Washington State over periods of 10 and 20 years. Figure 3-4 shows the forecast participation in water-related activities as the percent change in the number of people participating in the future compared to current (2003) levels.

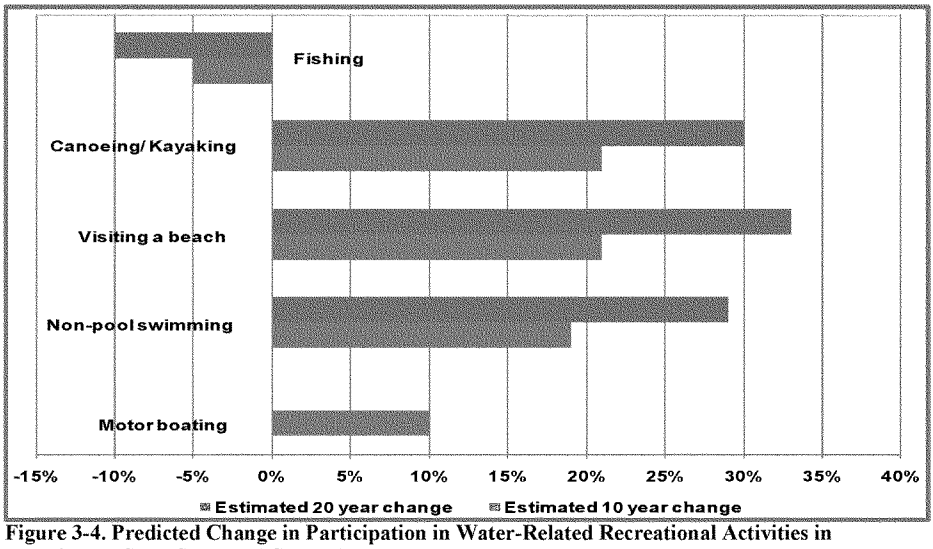


Figure 3-4. Predicted Change in Participation in Water-Related Recreational Activities in Washington State Source: IAC (2003)

Participation in some activities is predicted to be substantially higher—canoeing and kayaking, swimming, and beach visitation are all predicted to increase by around one-third over the next 20 years. However, other activities are anticipated to show slow growth or even a declining trend. The IAC states that new boat launch sites are rarely developed with proponents facing significant challenges in populated areas such as Puget Sound, where developable low bank waterfront property is at a premium. Slow expansion of the inventory of boating facilities will likely result in slow growth in motor boating.

The IAC notes that participation in motor boating appears to be linked closely to participation in recreational fishing, which is predicted to show negative growth. According to the IAC, the main reason for the expected decline in fishing is the perception of or actual decrease in the availability of fish for recreational harvest. While studies (e.g., Dawson and Wilkins 1980) show that the quality of a recreational fishing experience is not solely dependent on catching fish, but the prospect of catching at least some fish is an important factor motivating people to go fishing, and repeated poor catch during fishing trips undoubtedly diminishes angler satisfaction and discourages further participation. They conclude that unless there is considerable improvement in the numbers of fish available for recreational harvest, declines in fishing activity are expected.

Furthermore, the IAC suggests that the expected increases in the levels of other water-related activities may have to be adjusted downward if resource quality deteriorates. They observe that swimming, wading, surfing, SCUBA diving, and other water-contact activities are directly affected by water quality, including pollution and the presence of noxious weeds. Similarly, they note that photographing and observing wildlife depend on natural settings including habitat for species of interest. It is clear that the future of Puget Sound's whale-watching industry is contingent on robust populations of whales, which, in turn, is dependent on clean water and a healthy food source. The IAC draws the conclusion that, "For resource recreation to be sustained over time, resource protection must come first."

3.6.4.3 *Commercial Fisheries and Aquaculture*

Commercial fishing and shellfish production have long been important natural resource-based industries in the Puget Sound region that provide jobs, wages, profits, taxes, and a local food source. In addition, the commercial harvest of fish and shellfish is a significant part of the culture and heritage of the residents of the Puget Sound region.

The future viability of commercial finfish and shellfish harvesting is inexorably tied to specific species' populations and related policies developed for species protection including actions to restore the degraded ecosystems that finfish and shellfish depend upon. Section 3.4.3 describes past trends in finfish and shellfish fisheries, which may be instructional for predicting future commercial harvests. As discussed in the existing conditions section, over the past three decades, the combined tribal and non-tribal commercial fisheries harvest has decreased by 60%, from approximately 70 million down to 30 million pounds harvested annually. However, the rate of decline has lessened since the mid-1990s, although with significant annual variation. The state of Dungeness crab in Puget Sound appears to be healthy with an increasing trend in commercial harvest. In addition, shellfish aquaculture operations show steady growth in harvest levels, probably caused by increased acreage under production and improved culturing techniques.

Moreover, recent changes in management approaches suggest that some depressed commercial fisheries could improve. Although fish hatcheries did not prove to enhance fisheries as once predicted, and actually harmed wild salmon populations, improving hatchery practices represents

an opportunity to help recover salmon. Puget Sound populations of rockfish, one type of groundfish, have potential for recovery. Of the 17 marine fish stocks in Puget Sound that have been petitioned for listing as threatened or endangered under the ESA, about half are rockfish. In 2009, WDFW prepared a draft plan that includes a range of policies, strategies, and actions that could rebuild rockfish stocks (WDFW 2009). It is uncertain whether the proposed conservation efforts are sufficient to protect rockfish and allow rebuilding given their late maturation and low reproductive success.

Washington State is now the top producer of farmed clams, oysters, and mussels in the United States. Along with ocean acidification associated with increasing atmospheric carbon dioxide, the most direct threat to continued shellfish production in the Puget Sound region is land development, which is likely a major contributor of reduced water quality. While aquaculture production will likely increase in the next 50 years, trends in human development patterns, increased impervious surfaces, and hardening of shorelines continue in the Puget Sound region. The ecological requirements of Dungeness crab and commercially important bivalve shellfish make them vulnerable to stressors associated with human population increases. In the absence of remedial actions, the resulting increases in toxins, nutrients, and degradation of habitat may offset this potential growth in the industry, leading to the loss of a traditional employment opportunity, revenue, and Northwesterners' strong sense of place.

3.6.4.4 *Transportation*

Puget Sound residents benefit from high connectivity at the local and regional level. Transportation infrastructure, such as roadway expansion, has served as a catalyst for development intrusion into natural lands. Over the last 30 years, the number of roads within the region has doubled (PSRC 2010). Major public investments will be required over the next 50 years to maintain and upgrade the transportation system in light of projected population increases. The Transportation 2040 Plan (PSRC 2010) anticipates a need to invest $189 billion to $225 billion over the next 30 years to accommodate projected increases in population, employment, and commerce. In general, regional transportation plans involve expansion of public transit options, state highways and other major roads, non-motorized transportation (bike and walk improvements), and ferry systems.

3.6.5 Predicted Effects of Climate Change and Sea-Level Change

There is consensus among international and regional scientists that global climate change and associated sea-level change (SLC) will result in widespread and far-reaching changes to Puget Sound nearshore ecosystems. Projections of the specific implications of climate change show that impacts will occur to climate, water resources, forests, and coastal areas with forthcoming impacts to salmon, economics, and human health. Climate change will affect several general types of processes in Puget Sound that in turn affect its structure and function. The processes affected include sea-level, weather and temperature, large- and local-scale atmospheric forcing,

the water cycle, and ocean acidity (Pearson et al. 2011b). For the Puget Sound, climate change can be characterized by increased frequency of damaging storms and floods, lower riverine flows during summer, gradual inundation of low lying areas, increased erosion rates, loss or major shifts in nearshore habitats, escalating costs of maintaining and repairing infrastructure, effects on shellfish harvesting and agriculture, and seawater intrusion into coastal aquifers (Snover et al. 2005, Climate Impacts Group 2009).

Effects of SLC and weather patterns will vary by coastal area and landscape types. Along marine shorelines, increased erosion rates will increase frequency of landslides, larger erosional events may occur more often, and patterns of sediment transport on beaches will change, leading to complex, perhaps rapid shoreline changes. SLC will cause progressive loss of upper beach where the shoreline cannot retreat landward while other nearshore and estuary habitats may disappear if they cannot migrate landward (section 3.6.2 discusses impacts to vegetation types forming key habitats). SLC in river deltas will cause loss of nearshore habitats seaward of dikes, with increased intrusion of saltwater into the estuary, increased flooding, soil saturation, and potential changes in agricultural land use. Costs to maintain infrastructure including seawalls, levees, marinas, septic systems, and port facilities will increase. Costs to maintain land-based transportation systems such as roadways, bridges, and railways are also expected to increase.

The ecological changes associated with climate change and human responses to these changes are likely to affect ecosystem processes. In particular, physical processes will be affected by the forecasted SLC, changes in weather patterns including changing hydrology with increased winter flooding and lower summer flows, increased water temperature, and ocean acidification. SLC impacts include the loss of marsh habitat particularly if natural sedimentation is altered and cannot keep pace with the rate of change. All of these appear likely to significantly impact many of the ecosystem processes directly as well as indirectly through the actions people take to counteract the impacts of climate change. For example, SLC coupled with increased riverine flooding can directly affect nearly all of the nearshore ecosystem processes. Human response to SLC and changing inland hydrology can include the construction of structural countermeasures that put increased stress on ecosystems.

3.6.5.1 *Effects of Climate Change on Inland Hydrology*

The USACE Engineering and Construction Bulletin 2014-10 requires a qualitative analysis of climate change variability in hydrologic analysis for inland watersheds. In its climate change assessment for the Pacific Northwest region, the Corps of Engineers prepared a report synthesizing recent climate change and hydrology literature (USACE 2015).

The 2015 USACE literature review presents this summary of findings for the Pacific Northwest:

> "There is moderate consensus in the literature that annual average air temperatures will increase in the Pacific Northwest Region, and throughout the country, over the next century.

The largest increases are projected for the summer months. A strong consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long-term future compared to the recent past.

Projections of precipitation and streamflow in the study basin are less certain than those associated with air temperature. Results of the studies reviewed here are roughly evenly split with respect to projected increases versus decreases in future annual precipitation. There is, however, a strong consensus among the reviewed studies that future storm events in the region will be more intense and more frequent compared to the recent past.

Similarly, clear consensus is lacking in the hydrologic projection literature. For example, projections generated by coupling GCMs [Global Climate Models] with macro-scale hydrologic models in some cases indicate little change in future streamflows but in other cases indicate a potential increase in runoff in the study region. This lack of consensus across the literature is likely due to the varied topography of the region and the current ability of GCMs and regional climate models to consistently resolve topographic effects from local climate forcings."

Figure 3-5, taken from the USACE report, presents a graphical summary of the projected climate trends for the Pacific Northwest.

By the end of this century, ambient air temperatures are expected to increase by 3.2 to 9.7 °F. Air temperature extremes are expected to increase 4.5 to 14.4 °F, with the number of heat wave days expected to increase by up to 75 days per year. Plankton are highly sensitive to changes in temperature, and temperature driven shifts in plankton species and abundance could affect the food web, changing the composition of invertebrates, fish, and mammal communities. Increased algal productivity in surface waters and changes in circulation and upwelling due to warmer marine temperatures could exacerbate low-oxygen events (Snover et al. 2005, Glick et al. 2007, Newton et al. 2008).

The literature review found uniform agreement that the frequency of extreme storm events would rise. Runoff may increase by up to 200 mm/year. Decreased snowpack and earlier snowmelt are expected to contribute to lower summer stream flows, higher winter stream flows, and a change in the timing and extent of freshwater inputs into marine waters. The combined effects of warming stream temperatures and altered stream flows will very likely reduce the reproductive success for many salmon populations (Mantua et al. 2010). Changes in temperature and stream flow can influence the spring bloom timing of algae and zooplankton with attendant impacts to other trophic levels timed to historical blooms (reduced growth and survival). Changes in timing of freshwater input may affect the circulation, stratification, and mixing of the Sound. In winter months, projected increases in stream flow would increase stratification in Puget Sound, which

can affect upwelling of nutrient supplies to surface waters, phytoplankton growth, the availability of dissolved oxygen to waters at depth, and pollutant flushing (Newton et al. 2003).

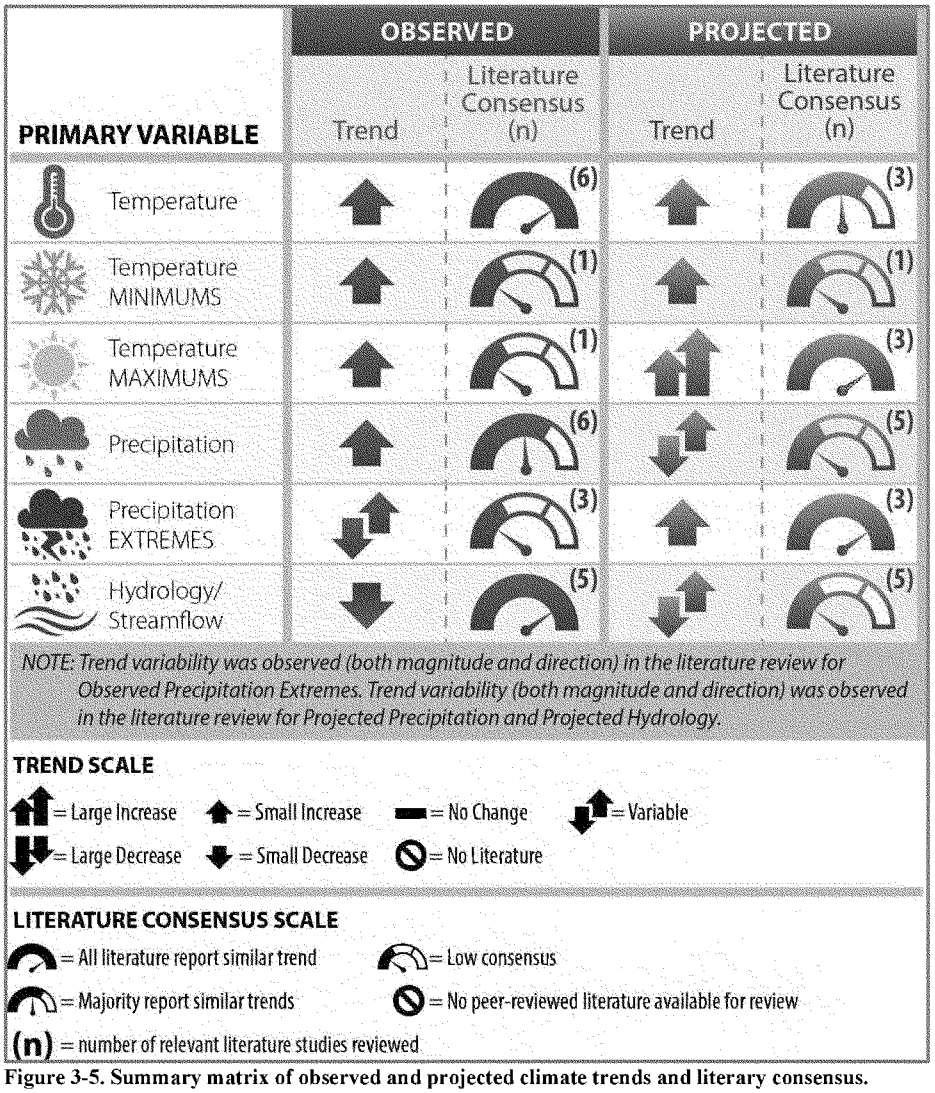


Figure 3-5. Summary matrix of observed and projected climate trends and literary consensus.

The increasing rate and amount of human-caused CO_2 emissions is progressively affecting the ocean system and linked estuaries such as Puget Sound, causing the acidity of seawater to

increase. When CO_2 reacts with seawater it creates carbonic acid, lowering the pH level of the of the ocean water (acidifying). At the same time, the reduction in pH reduces the availability of carbonate ions, which play an important role in shell formation in a number of marine organisms. This acidification of ocean water is harming marine organisms that build calcium carbonate shells (calcifers) such as zooplankton, oysters, and mussels and can, in turn, affect higher trophic levels. In Puget Sound 30% of all species are calcifers. In the subsurface waters of Hood Canal, pH values as low as 7.4 have been observed; these values are more than 200% more acidic than open ocean surface waters (Feely et al. 2010). Recent declines and mass die-off of commercial oyster larvae are thought to have possible links to ocean acidification.

The design concept for the project focuses on removing human-made structures or features. Once the impediments are removed form a site, it is expected that the natural system will be dynamic and more resilient to climate change effects, including changes in inland hydrology. Although the project design establishes initial habitat types and channel configurations, the project is not constrained to maintain a specific combination of habitat types into the future. Site designs increase the area of tidal exchange and riverine inundation when compared to present conditions but do not prescribe a particular mix of habitat types. For example, increased channel complexity in levee setback areas will allow refuge for fish under a wider variety of conditions even when winters are wetter and summers are drier. The channels will be allowed to migrate and adapt to changing hydraulic conditions, which may result in shifts between saltwater, freshwater and upland vegetation, however benefits will still accrue in the restored areas. The project design also takes into account regional efforts by others for estuarine and riparian restoration that are being implemented independently in nearby areas.

3.6.5.2 *Sea Level Change Predictions*

The Intergovernmental Panel on Climate Change (IPCC 2007) indicates that, in the 20th century, the rate of global mean sea level (GMSL) change has been 1.7 ± 0.5 mm/year, or between five and nine inches. Vertical land movement (VLM) strongly influences sea-level change (SLC) in Puget Sound and affects local SLC differently in the various sub-basins. VLM varies from uplift on the Olympic Peninsula creating a net sea-level decline, to subsidence in the southern sub-basins resulting in net sea-level rise.

The Nearshore Study is required to consider the effects that SLC could have on the management, planning, design, construction, operation, and maintenance of projects (Corps Engineering Regulation [ER] 1100-2-8162 [USACE 2013] hereinafter referred to as SLC Regulation). The SLC Regulation requires feasibility studies to examine three scenarios to consider the sensitivity and adaptability of projects to sea level change. These scenarios include "low," "intermediate," and "high" forecasts of SLC. These scenarios correspond to the historical SLC trend computed from local, long-term, tidal stations and two National Research Council GMSL change acceleration curves (National Research Council 1987) modified by new data from the IPCC. The analysis requires combining local VLM with values from the three SLC scenarios to determine

total SLC for each scenario forecast for the period of analysis, which extends 50 years beyond the year when the first project benefits can be expected. Figure 3-6 shows the three predicted sea level change curves for tide gauges at Seattle, Port Townsend and Friday Harbor, in or near Puget Sound near the project sites. The predictions are similar in magnitude around the Puget Sound, with a 100-year high sea level rise of about six to seven feet, a 100-year intermediate rise value of about two feet, and the 100-year low value of under one foot of rise.

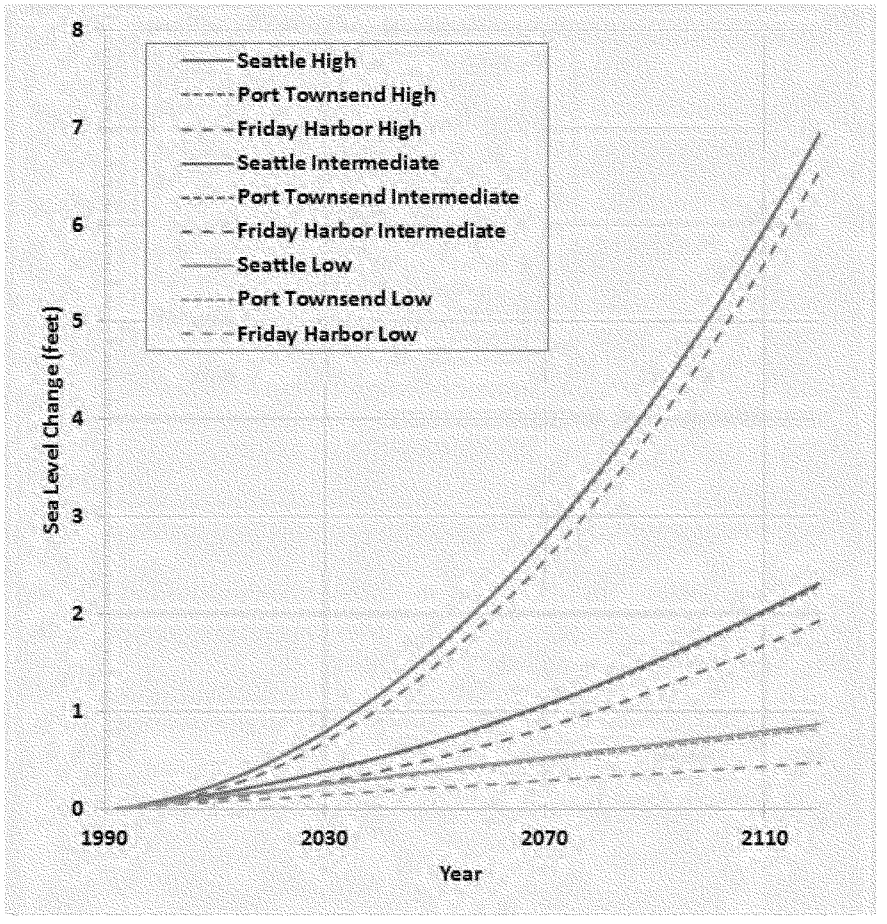


Figure 3-6. Sea level Change Predictions for Tidal Stations Affecting PSNERP Sites, per ER-1100-2-1862. Data from Seattle Gage 9447130 (VLM = -0.54 mm/yr), Port Townsend Gage 9444900 (VLM = -0.24 mm/yr) and Friday Harbor Gage 9449880 (VLM = 0.58 mm/yr). Source: USACE Sea-Level Change Curve Calculator (2015.46).

Local SLC estimates in the Hood Canal, South Puget Sound, and Whidbey sub-basins present the most uncertainty as no active tidal stations exist in these regions and estimates are based on the nearest available VLM correlated gage. Under ER 1100-2-8162, several options are available for feasibility level design. Design of the recommended plan opted to use the approach described in Paragraph 6.d (1) of the guidance - working within a single scenario and identifying the preferred alternative under that scenario. That alternative's performance was then evaluated under the other scenarios to determine its overall potential performance. This approach is best used when plan performance is not highly sensitive to sea level change.

From the ecosystem restoration standpoint, the project is not very sensitive to sea level change. The design concept focuses on removing human-made structures or features to allow natural processes to evolve freely in the absence of impediments. For example, tidal marshes can adapt to sea level change by building elevation to keep pace with the rising water levels, as long as an adequate supply of sediment and/or organic matter accumulation is available. Although the project design establishes initial habitat types and channel configurations, the project is not constrained to maintain a specific combination of habitat types into the future. By expanding freshwater and saltwater inundation area over present conditions through project actions, benefits can accrue in different types of habitat so the number of AAHUs is not strongly a function of sea level. This increase would occur under all sea level change scenarios. The project design takes into account other regional efforts for estuarine restoration and the possibility of managed coastal retreat to allow habitat to keep moving as sea level changes. For these reasons, all alternatives, i.e. all the sites considered in the plan formulation, are expected to perform equally under the different scenarios and the selection of recommended alternative is not sensitive to the rate of sea level change. Structural features within each site are designed to be resilient to sea level change or to allow OMRR&R cost contingency for sea level change but are not necessarily unaffected by sea level change. Levee design uses the existing level of flood risk as a formulation baseline so that future with-project risk is the same as future without-project risk.

This analysis of available scenarios and projections provides ranges of local SLC rates that the Nearshore Study can use to incorporate SLC considerations into the analysis and evaluation of alternatives. The study team will continue to evaluate sea-level change for site-specific project planning during the preconstruction engineering and design (PED) phase.

One consideration for coastal climate change is the effect of high winds on wave heights, storm surge and wave setup. While extreme precipitation events are expected to increase in the Pacific Northwest, recent literature indicates lower tropospheric winds are expected to change little (Warner et al. 2015, Cheng et al. 2015) so that high wind events are not expected to worsen in the near future. In fetch-limited areas, such as in most of Puget Sound, wave heights would not be expected to increase. In those areas which are depth-limited, however, sea level rise will lead to higher wave heights prior to wave breaking and correspondingly increased water levels.

4 PLAN FORMULATION

This chapter explains the process used to formulate, evaluate, and compare alternative plans. To develop restoration plans and a comprehensive restoration master plan for the Puget Sound nearshore, the Study team used the process illustrated in Figure 4-1. These steps are described in more detail throughout this chapter.

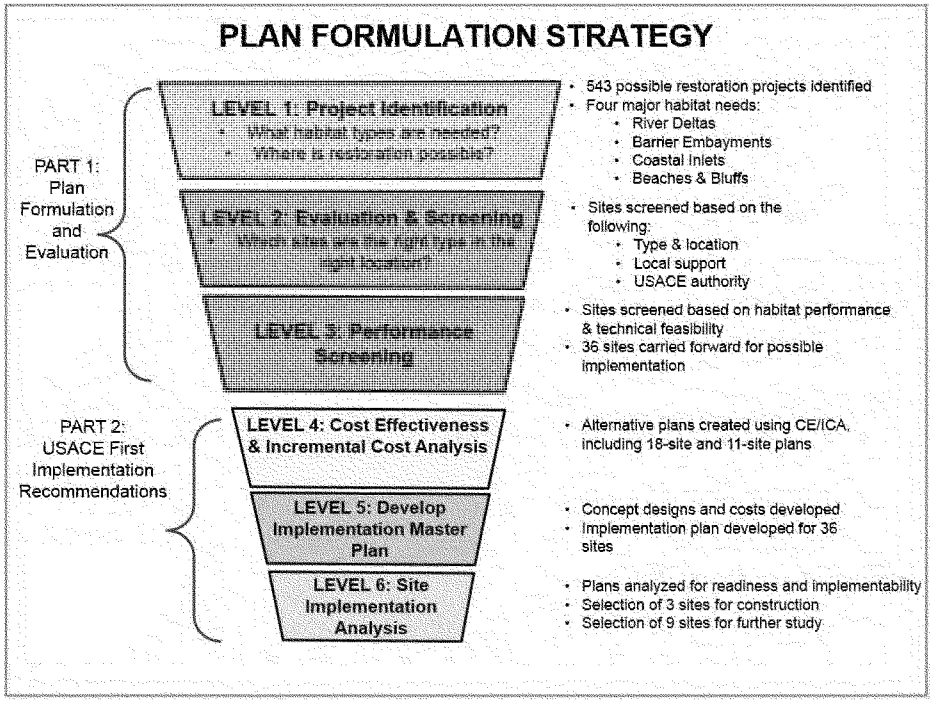


Figure 4-1. Summary of Plan Formulation Process

4.1 LEVEL 1: PROJECT IDENTIFICATION

Level 1 of the plan formulation strategy includes identification and screening of management measures as well as initial site identification for potential restoration projects across the nearshore zone based on the types of habitat to be restored in the most critical areas. The following sections summarize this first level of the plan formulation process.

4.1.1 Management Measures – "Right Action"

Management measures are features or activities that can be implemented at a specific geographic site to address one or more planning objectives. To determine the "right action" for potential restoration activities in the Puget Sound nearshore zone, the Study team identified 21 management measures that are outlined in a report titled, Management Measures for Protecting and Restoring Puget Sound Nearshore (Management Measures Technical Report, Clancy et al. 2009). Structural measures (e.g., armor removal, dike removal, channel rehabilitation, etc.) and non-structural measures (invasive species control, physical exclusion, public education, etc.) were identified and evaluated. A summary of the 21 management measures and their relationships to nearshore ecosystem processes are shown in Table 4-1. It should be noted that some of the management measures are not within the Corps' ecosystem restoration authority. They are included in the table to capture a complete list of possible measures but were not carried forward for future consideration (these measures are shaded in gray Table 4-1). The process used to evaluate and screen measures is summarized in the following paragraphs.

Table 4-1. Potential of Management Measures to Influence Nearshore Processes

No.[1]	Management Measure[2]	Relationship to Puget Sound Nearshore Ecosystem Processes ● = strong effect; ◗ = weak effect; blank = no relationship									
		Sediment Supply and Transport	Beach Erosion and Accretion	Distributary Channel Migration	Tidal Channel Formation and Maintenance	Freshwater Input	Tidal Hydrology	Detritus Recruitment and	Exchange of Aquatic Organisms	Solar Radiation (Sunshine)	Wind and Waves
1	Armor (a) Removal	●	●			◗		●			●
	(b) Modification		◗			◗					
2	Beach Nourishment	●	●								
3	Berm or Dike (a) Removal	●		●	●	●	●	●	●		◗
	(b) Modification	◗			◗	◗	◗	◗	◗		
4	Channel (a) Rehabilitation	●		◗	◗	●	●	●	●		
	(b) Creation	◗			◗	●	◗	◗	◗		
5	Contaminant (a) Removal								◗		
	(b) Remediation								◗		
6	Debris Removal	◗	◗		◗						
7	Groin (a) Removal	●	●	◗	◗	●	◗	◗	●		●
	(b) Modification	◗	◗	◗	◗	◗	◗	◗	◗		◗
8	Habitat Protection Policy or Regulations[3]	◗	◗	◗	◗	◗		◗	◗		◗
9	Hydraulic Modification	◗				◗	◗	◗	◗		◗
10	Invasive Species Control	◗	◗		◗	◗	◗	◗	◗	◗	◗
11	Large Wood Placement	◗	◗	◗	◗			◗	◗		◗
12	Overwater Structure (a) Removal	◗	◗							●	◗
	(b) Modification									◗	◗

No. [1]	Management Measure[2]	Relationship to Puget Sound Nearshore Ecosystem Processes ● = strong effect; ◗ = weak effect; blank = no relationship									
		Sediment Supply and Transport	Beach Erosion and Accretion	Distributary Channel Migration	Tidal Channel Formation and Maintenance	Freshwater Input	Tidal Hydrology	Detritus Recruitment and	Exchange of Aquatic Organisms	Solar Radiation (Sunshine)	Wind and Waves
13	Physical Exclusion								◗		
14	Pollution Control								◗		
15	Property Acquisition and Conservation[4]	●	●	●	●	●	●	●	●	●	●
16	Public Education and Involvement[5]	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
17	Revegetation	◗	◗	◗		◗		◗		◗	◗
18	Species Habitat Enhancement								◗		
19	Reintroduction of Native Animals								●		
20	Substrate Modification	◗	◗		◗	◗			●		◗
21	Topography (a) Restoration	●	●	●	●	●	●	●	●		●
	(b) Creation	◗	◗			◗	◗	◗	◗		◗

Notes:

1 The following management measures are non-structural: 5, 8, 10, 13, 14, 15, 16, 17, 18, and 19.

2 Some management measures are separated into rows labeled (a) and (b) to distinguish variation in the degree of process restoration between full removal of a stressor and partial removal/modification of the stressor.

3 The Habitat Protection Policy or Regulations management measure influences process via specific regulations such as the Shoreline Management Act and the Growth Management Act (critical areas ordinances), which limit shoreline armoring, overwater structures, and removal of riparian vegetation; storm water regulations, which require management of runoff and infiltration; and other regulations that protect ecosystem processes.

4 The Property Acquisition and Conservation management measure has potential to influence all processes to some degree and is an essential measure for long-term protection of ecosystem processes.

5 Public Education and Involvement potentially influences most ecosystem processes, through indirect mechanisms with varying durability.

The 21 management measures can be classified into groups as follows:

- **Restorative Measures** – These measures exert long-lasting effects on ecosystem processes and will often provide the best opportunity of achieving complete restoration of processes. They primarily involve removal of human-made stressors that physically impede processes. This also includes structural measures that provide immediate benefits in terms of habitat structure. Sustainability of these measures requires intact ecosystem processes.
- **Prerequisite Measures** – Includes measures that are often required prior to or in conjunction with other measures.
- **Protective Measures** – Measures such as these are a critical part of an overall recovery strategy. While important, these types of measures would not be implemented by the Corps as they are typically not within the Corps' ecosystem restoration mission area and authorities; therefore, protective measures are not considered further in this study.

Restorative management measures are considered keystone elements of sustainable restoration because they directly address degradation of the processes that create and sustain nearshore ecosystems. Of the 21 management measures originally identified, nine management measures were classified as restorative and were carried forward in the formulation of alternative plans.

The nine restorative management measures and their relationships to the planning objectives appear in Table 4-2. An expanded discussion of the management measures carried forward for each site included in the recommended plan is presented in Chapter 6.

Table 4-2. Relationship between Objectives and Management Measures

Management Measures[1]	Objectives		
	Restore Deltas	Restore Beaches	Restore Embayments
Armor Removal or Modification	✓	✓	✓
Berm or Dike Removal or Modification	✓		
Channel Rehabilitation or Creation	✓		✓
Groin Removal or Modification		✓	✓
Hydraulic Modification	✓		✓
Overwater Structure Removal/ Modification		✓	✓
Topography Restoration	✓	✓	✓
Large Wood Placement	✓	✓	✓
Revegetation	✓	✓	

Notes: [1] Based on Management Measures Technical Report (Clancy et al. 2009)

4.1.2 Identification of Restoration Strategies – "Right Place"

To determine the "right places" for restoration in the Puget Sound nearshore zone, the Study team conducted an analysis to determine where process-based restoration would have the greatest likelihood of successfully achieving planning objectives. This analysis is documented in the Strategies Report (Cereghino et al. 2012). The analysis uses preexisting, Sound-wide, spatially explicit information on nearshore landforms, stressors, and land use.

As described in section 1.8.3, the Change Analysis quantified structural and physical change between historic (1850s-1890s) and current (2000-2006) conditions. This analysis correlates the location, occurrence, and amount of stressor impact on nearshore ecosystems in the context of dominant ecosystem processes. Based on the historic and current conditions, the report presents four restoration strategies intended to assist in achieving the three Nearshore Study planning objectives. These four strategies are the foundation of site identification, where the Study team identified potential locations where one or more measures can be implemented to restore river deltas, barrier embayments, coastal inlets, and beaches. In other words, the strategies define site-specific locations in the Puget Sound Region where the objectives can be directly addressed.

Table 4-3 shows the correlation between the planning objectives and the strategies. The resulting strategic recommendations are presented (in part) as maps indicating where the Study team recommends focusing efforts to implement one or more process-based ecosystem restoration measures for the four strategies. As an example, the map illustrating the recommended approach for the River Deltas strategy is displayed in Figure 4-2. The maps of the other three strategies can be found in the Engineering Appendix.

Table 4-3. Nearshore Planning Objectives and Strategies

Planning Objective	Strategy Name	Description
Restore connectivity and size of large river deltas	River Delta	Protect and restore fresh water input and tidal processes where major river floodplains meet marine waters.
Restore the number and quality of coastal embayments	Barrier Embayment	Protect and restore sediment input and transport processes to littoral drift cells where bluff erosion sustains barrier beaches that form barrier embayments and restore the tidal flow processes within these partially closed systems.
	Coastal Inlet	Protect and restore tidal inflow processes in coastal inlets, and protect and restore fresh water input and detritus transport processes within these open embayment systems.
Restore the size and quality of beaches	Beach	Protect and restore fresh water input and tidal processes to littoral drift cells where bluff erosion sustains beach structure.

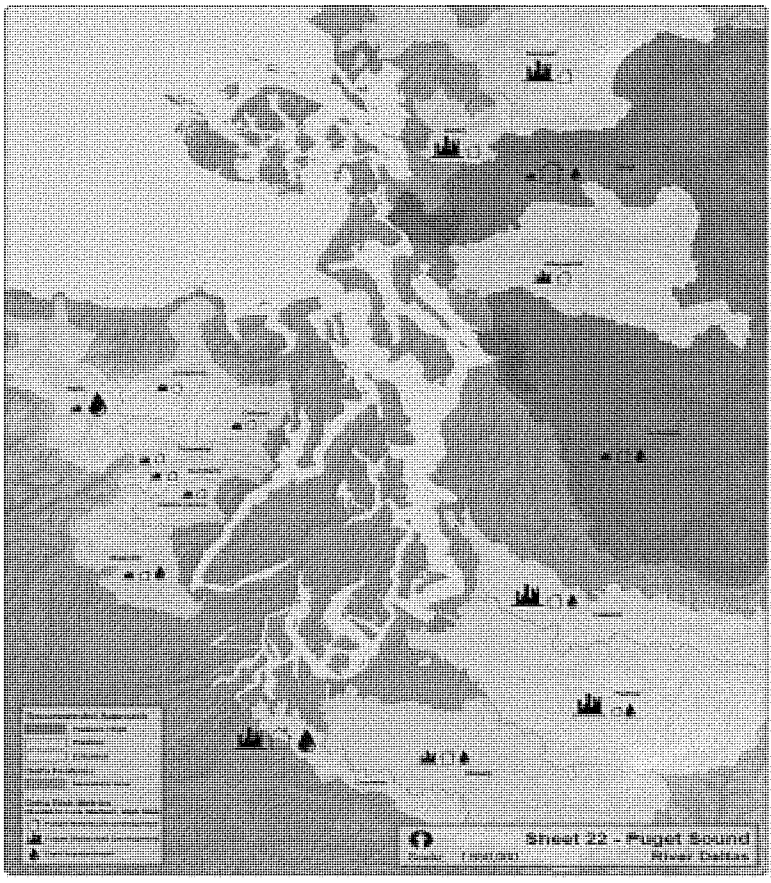


Figure 4-2. Map of Strategies Analysis for Deltas (from Cereghino et al. 2012)

4.1.3 Site Identification

To foster collaboration and maximize efficiency in creating an initial list of potential restoration sites where one or more measures could be implemented, the Nearshore Study used the knowledge base of local restoration practitioners and organizations and the extensive backlog of restoration ideas generated by these groups. Potential project ideas were generated by groups across the restoration community including Lead Entities, Marine Resource Committees, Salmon Enhancement Groups, tribes, etc. Information they provided was used to populate the Nearshore Database, which became a comprehensive list of restoration ideas throughout Puget Sound. The Nearshore Database was created by the Nearshore Study and has been maintained by the Study team since then. In addition to serving as the pool of potential solutions to be used by the

Nearshore Study, the Nearshore Database serves as a tool for documenting the scope of Sound-wide restoration needs and opportunities. The restoration community was provided several opportunities between 2006 and 2010 to add and update entries in the database. The Nearshore Study improved overall data quality and consistency by assigning spatial coordinates and translating the restoration descriptions into management measures using the *Management Measures Technical Report* (Clancy et al. 2009). A final call to the restoration community for submittals of new entries into the database was made in May 2010, resulting in a total of 543 entries (site records) in the database.

4.2 LEVEL 2: EVALUATION AND INITIAL SCREENING

Level 2 of the plan formulation strategy included initial screening of the 543 site records contained in the Nearshore Database. Sites that occurred in a location identified by one of the four strategies (including deltas, barrier embayments, coastal inlets, and beaches) were retained for further consideration. The team determined whether the remaining site records proposed the "right action" in the "right place;" in other words, if it centered on at least one of the seven restorative management measures that target the spatially-explicit strategic needs of the site. For example, if a proposed restoration action included management measures that restore ecosystem processes that support deltas (right action), and if it was located in a delta where restoration was likely to succeed (right place), then it would be eligible for further consideration.

To complete initial screening of the 543 site records, Study team planners, biologists, project managers and members of the Nearshore Science Team met to systematically review the sites considering the following elements:

- the landforms present at a given site,
- the management measures proposed,
- the level and type of degradation present at a given site
- the position of the site in the landscape.

Sites that included one or more measures considered to have a strong effect on a strategy (i.e., those most able to restore the associated process or processes) were retained for further consideration. When these sites included one or more measures considered to have a weak effect on the strategy (for example, a measure that would accelerate benefit accrual without addressing underlying processes), the sites were retained for further consideration but the weakness was noted. Sites that contained no restorative management measures were excluded from further evaluation. This initial screening step narrowed the list of sites from 543 to 198 to be carried forward for additional evaluation.

Study team members then met with representatives of the local restoration community to understand local constraints, confirm project details, and verify proponent interest. Sites were removed from the list of 198 for an array of reasons including significant concerns about

landowner willingness, lack of public support, or the likelihood that the restoration may be completed by others. In some cases, two site records dealt with adjacent lands and were combined into one. Duplicate entries for the same or similar action with different project names were identified and merged in consultation with the project proponent(s). The result was a list of 46 site records suitable for development of conceptual designs, cost estimates, and additional evaluation.

4.2.1 Site Conceptual Designs

An interdisciplinary Conceptual Design Team (CDT) comprised of Study team members and expert consultants conducted field visits to each of the 46 candidate restoration sites. The CDT assessed site conditions, gathered data to characterize the site, obtained photographs, and evaluated "on-the-ground" opportunities and constraints. The CDT evaluated each site using a set of screening criteria to determine whether the proposed action is likely to achieve the Nearshore Study's restoration objectives. Screening criteria were meant to identify any "fatal flaws" of the sites and included determining the following: (1) whether the site was sufficiently described and spatially defined to allow the Study team to develop conceptual designs and develop quantity estimates, (2) whether the site was consistent with one or more of the Nearshore Study's restoration objectives and strategies, and (3) whether local proponents had precluded the Study team from including the site when developing conceptual designs. The results of this work are documented in characterization reports that describe the potential restoration opportunities in terms of ecological effectiveness and engineering feasibility (Strategic Restoration Conceptual Engineering — Final Design Report (aka "Conceptual Design Report", ESA et al. 2011b). As a result of this evaluation and screening, six sites were removed from further consideration. Additionally, the four Big Quilcene River sites were combined into one site, and the two Telegraph Slough sites were combined, leaving 36 sites to proceed to conceptual design.

As described in section 4.1, a suite of 21 different management measures were identified for implementation across Puget Sound. Management measures identified for this study are fully outlined in the Management Measures for Protecting and Restoring Puget Sound Nearshore (Management Measures Technical Report, Clancy et al. 2009). Structural measures (e.g., armor removal, dike removal, channel rehabilitation, etc.) and non-structural measures (invasive species control, physical exclusion, public education, etc.) were identified and evaluated. A summary of the 21 management measures and their relationships to nearshore ecosystem processes are shown in Table 4-1.

Based on the results of the management measures evaluation and screening step, two site designs, one "full" and one "partial," were developed for each of the remaining 36 sites. A "full" design includes management measure(s) to fully remove site-specific stressors, maximize the area of influence, and maximize improvements in ecosystem benefits. Land ownership was not considered as a potential constraint in developing the full restoration alternative; however, the continued existence of major durable infrastructure (e.g., transmission lines, highways, utilities,

railroads) was generally assumed. The full design can be understood as a way to maximize site potential for process-based restoration by removal of stressors to the fullest extent possible, often expanding upon the original proposal for the site.

A second "partial" design was developed that addressed known constraints and concerns (from landowners, user groups, and the community) while still achieving process-based restoration. The partial design could differ from the full design in the number or type of management measures implemented, the area over which a management measure was applied, and/or the size or type of tidal openings. The partial restoration design was often similar to the description initially submitted to the Nearshore Database by the project proponent.

This step resulted in 72 designs at 36 sites, shown in Figure 4-3. Narrative descriptions of the sites, designs, assumptions, and future needs, along with the conceptual design plans, are documented in the Conceptual Design Report (ESA et al. 2011b).

It should be noted that this step of the plan formulation process was intended to identify conceptual alternatives for each site using the measures carried forward from preliminary screening while still evaluating a large number of potential alternatives across the Puget Sound. While only two site designs were developed at this stage, sites that were carried forward in the recommended plan underwent additional site-specific plan formulation and design. Chapter 6 describes the additional site-specific plan formulation steps that were used to further develop and refine site designs, including identification of site-specific planning objectives, constraints, and measures for each of the sites included in the recommended plan. This process allowed the study team to identify alternatives at a broad, regional scale and further refine alternatives at the site-specific scale as the plan formulation and evaluation process continued.

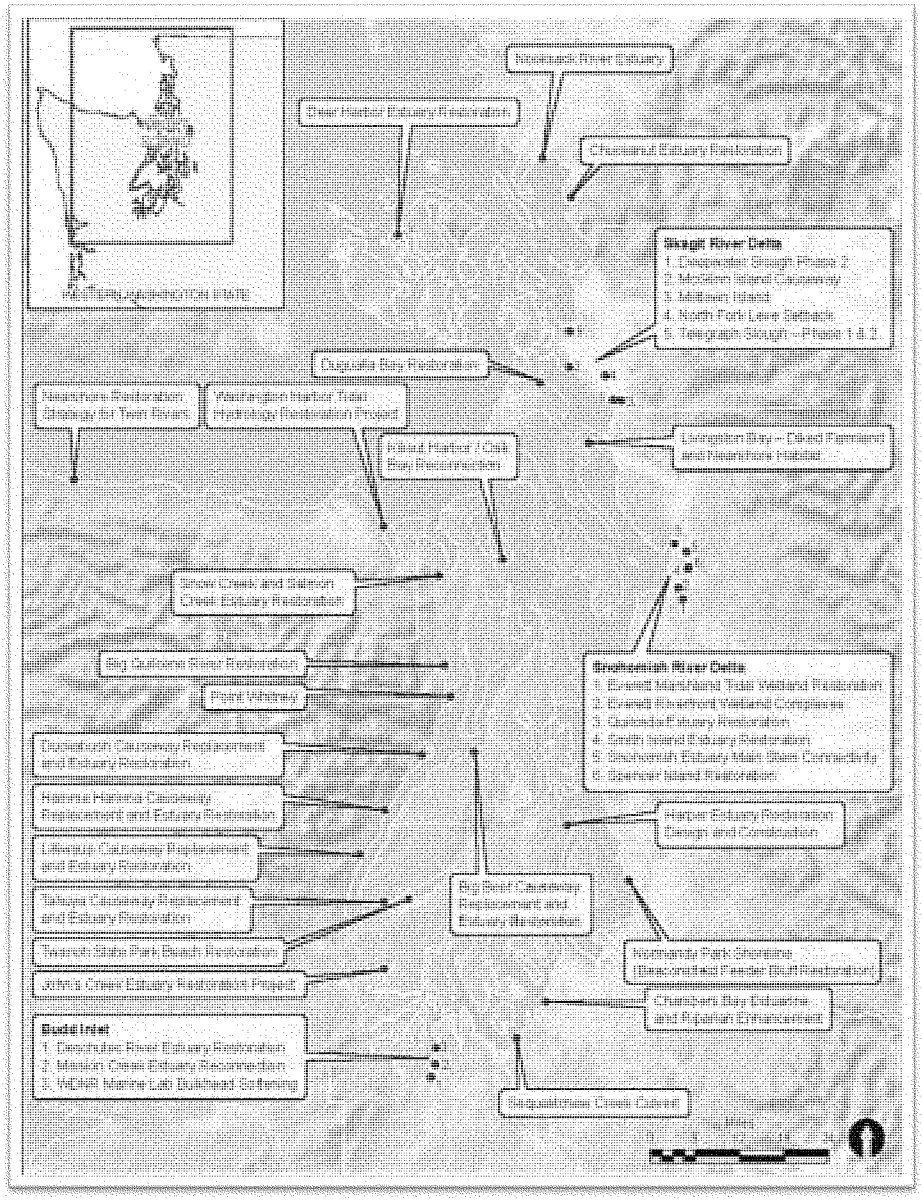


Figure 4-3. Location of 36 Sites

4.3 LEVEL 3: PERFORMANCE SCREENING

Level 3 of the plan formulation strategy included performance screening of the sites in the master plan. To effectively evaluate the 36 sites carried forward, the Nearshore Study team completed additional analysis including development of parametric cost estimates and evaluation of ecosystem outputs. The following sections outline the assumptions and outcomes of this work.

4.3.1 Evaluation of Site Benefits

An interdisciplinary team including Corps staff, members of the NST, and consultants developed an ecosystem output (EO) model to quantify the benefits that each site would provide. The framework of this model is consistent with the Nearshore Study's approach of restoring the ecosystem processes and structures to provide ecosystem functions to support habitats, biodiversity, and productivity. The model output is a product of quantity and quality. The quantity component of the model equation is defined as the area of restored process (in acres), and the quality component is comprised of multiple components that capture process, structure, and function. These three quality components are derived from calculations based on spatially explicit data in the Nearshore Geodatabase[1]:

- The process component is represented by one index: process degradation.
- The structure component is represented by five landscape indices: scarcity of landforms, heterogeneity of landforms, long-shore connectivity, cross-shore connectivity, and sinuosity.
- The function component is represented by one index modified from Simenstad et al. (2011): a site's ability to provide ecological outputs of regulating and supporting ecosystem functions. Only habitat-supporting and ecologically-related outputs were used (see Appendix G).

The model equation combines these components as follows:

Quantity Quality

EO = A * [(P^2 + S + F)/maximum possible score]

Where:

EO – ecosystem output (project benefits)

A – area of restored process, in acres (Quantity score)

P – process degradation index score, scale 0 – 10 (process component of Quality score)

S – 2 (Sc + H + Lc + Cc + Sn), scale 0 – 10 (structure component of Quality score)

Sc- scarcity, scale 0-1

H- heterogeneity, scale 0-1

[1] The Nearshore Geodatabase was initially compiled as part of the Change Analysis (Simenstad et al. 2011)

Lc- long-shore connectivity, scale 0-1
Cc- cross-shore connectivity, scale 0-1
Sn- sinuosity, scale 0-1

F – Ecosystem Functions Goods & Services Tier 2 score, scale 0 – 10 (function component of Quality score)
Maximum possible score for quality: 120

A documentation report titled "Puget Sound Nearshore Ecosystem Output Model Documentation Report" describes the theory, framework, and detailed methodology of this model and the associated indices listed above (see Appendix G). The Nearshore Study's Strategic Science Peer Review Panel (SSPRP, described in further detail in section 8.4) reviewed the documentation report. The Corps has reviewed and approved this model for use in this study.

4.3.2 Evaluation of Site Costs

Costs were estimated for the 36 sites and input into the Institute for Water Resources Plan for generation of alternatives and for CE/ICA. Costs used in the formulation and evaluation of alternatives are the economic costs of each site design, including pre-construction, engineering, and design (PED) costs; construction and construction management costs; and real estate costs.

Costs for PED, construction, and construction management were developed by Corps cost engineers in Micro-Computer Aided Cost Estimating System (MCACES)[2] using the quantities provided with the conceptual designs, standard features and rates, and input from the PDT. When necessary, quantities were developed by the cost engineer if not provided in the conceptual design reports. Items such as the fuel rates, rock pricing, haul distances, and markups were discussed within the team and held consistent throughout all site designs. Certain features, such as some bridges and levees, were assumed to have similar designs but were sized according to the needs of each alternative site design. Costs developed for the CE/ICA analysis utilized costs at the October 2011 price level and were annualized using a 4% discount rate (FY12 rate) and assumed similar construction durations across sites. Monitoring and adaptive management costs were included as a cost contingency and were confirmed to not to vary considerably among sites, with the study team concluding that these costs would not impact the outcomes of the CE/ICA analysis. Monitoring costs ranged from 0.9-0.95% and adaptive management costs ranged from 2.58-2.85% for each of the sites.

Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs were not included in this phase of evaluation because little was known about the cost of OMRR&R at the conceptual design level. Expected changes to OMRR&R were evaluated at a conceptual level, but it was subsequently determined that inclusion of OMRR&R costs had a moderate level of uncertainty but would not affect the screening of alternatives at this phase. OMRR&R is

[2] MCASES is cost estimating software used by Corps cost engineers.

evaluated and presented in the project costs for the recommended plan in Chapter 6 of this report.

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 6.7 and the Cost Engineering Annex of Appendix B.

4.3.3 Additional Screening

An additional round of qualitative evaluation and screening was completed based on site benefits, preliminary costs, technical feasibility, and overall readiness to proceed. Similar to the screening described in section 4.2.1, screening criteria were meant to identify any "fatal flaws" of the sites or site designs ("full" and "partial") and included determining the following: (1) whether the site or site design was sufficiently described and spatially defined to allow the Study team to develop conceptual designs and develop quantity estimates, (2) whether the site or site design was consistent with one or more of the Nearshore Study's restoration objectives and strategies, and (3) whether the site or site design generally met site-specific objectives and avoided site-specific constraints.

This evaluation step was the primary mechanism to qualitatively screen the "full" or "partial" designs for each site as well as identify any "fatal flaws" with sites regardless of whether the "full" or "partial" design was carried forward. After this additional qualitative screening was completed, 41 designs were screened out from further evaluation, leading to 31 designs remaining. In addition, 12 sites were screened out from further evaluation during this step, leading to 24 sites remaining. As a result of this evaluation and screening step, 31 different site designs (representing a level of restoration labeled "full" or "partial") located at the 24 unique sites were carried forward for additional analysis, evaluation, and screening.

4.3.4 Summary of Site Benefits and Costs

Table 4-4 provides an overview of the benefits and costs for the 31 site designs located at 24 sites. The site designs are grouped by strategy, which is shown in the left-most column.

Table 4-4. Benefits and Costs for Sites, by Strategy (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs[1]	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output
Delta	Big Quilcene Partial	$35,073	$1,632	25.5	0.6
	Deepwater Slough Partial	$6,652	$310	269.6	90.2
	Duckabush Full	$71,085	$3,309	39.4	12.9
	Duckabush Partial	$58,403	$2,719	38.1	12.3
	Everett Marshland Fnll	$357,549	$16,644	829.1	349.3

Strategy	Site Design Name	Costs ($1,000s) First Costs[1]	Costs ($1,000s) Total Average Annual Costs	Benefits Area	Benefits Average Annual Net Ecosystem Output
	Everett Marshland Partial	$154,286	$7,182	427.4	167.8
	Milltown Island Partial	$4,246	$198	214.2	64.0
	Nooksack River Delta Partial	$331,473	$14,132	1,807	650.5
	North Fork Skagit Delta Full	$64,393	$2,998	256.1	53.7
	Spencer Island Partial	$16,916	$787	313.2	136.0
	Telegraph Slough Full	$188,613	$8,779	832.2	253.9
	Telegraph Slough Partial	$93,922	$4,372	146.9	16.3
Beach	Beaconsfield Feeder Bluff Full	$7,929	$369	6.9	2.2
Beach	Beaconsfield Feeder Bluff Partial	$3,027	$141	5.5	1.3
Beach	Twin Rivers Partial	$5,546	$258	4.3	0.2
Beach	WDNR Budd Inlet Beach Full	$9,569	$446	2	1.1
Barrier Embayment	Big Beef Creek Estuary Full	$32,629	$1,519	29.6	7.9
Barrier Embayment	Dugualla Bay Partial	$72,289	$3,365	572	162.6
Barrier Embayment	Livingston Bay Full	$12,863	$599	244.6	41.6
Barrier Embayment	Livingston Bay Partial	$12,062	$561	238.7	40.5
Barrier Embayment	Point Whitney Lagoon Full	$9,522	$443	6.1	2.0
Coastal Inlet	Chambers Bay Full	$288,020	$13,408	83.5	8.5
Coastal Inlet	Chambers Bay Partial	$96,699	$4,502	47	3.4
Coastal Inlet	Deer Harbor Estuary Full	$6,679	$311	16.1	4.8
Coastal Inlet	Harper Estuary Full	$12,240	$569	6.2	1.7
Coastal Inlet	Harper Estuary Partial	$16,025	$746	5.7	1.1
Coastal Inlet	Lilliwaup Partial	$30,619	$1,425	19.6	1.1
Coastal Inlet	Sequalitchew Full	$166,320	$7,743	4.5	0.9
Coastal Inlet	Snow/Salmon Creek Estuary Partial	$37,798	$1,760	52.2	6.8
Coastal Inlet	Tahuya River Estuary Full	$28,917	$1,346	36.1	7.6
Coastal Inlet	Washington Harbor Partial	$17,666	$822	14	0.6

Note: 1. First costs include real estate, design, construction, and construction management.

4.4 LEVEL 4: COST EFFECTIVE AND INCREMENTAL COST ANALYSIS

Level 4 of the plan formulation strategy included cost effective and incremental cost analysis for the 24 sites carried forward from the previous step. As discussed in section 4.1.2, four restoration strategies were developed to address the planning objectives, with one strategy to address Objective 1 (deltas), two to address Objective 2 (embayments - one strategy for barrier embayments and one for coastal inlets), and one to address Objective 3 (beaches). Alternative plans were initially formulated to address each strategy because of the broad variety of and differences between ecological benefits that accrue from restoration of the different landforms. Restoration of the different landforms can have not only cumulative benefits, but potentially

synergistic benefits as well. For example, restoring a large river delta site would benefit rearing salmonids, while restoring a beach would restore spawning habitat for forage fish, a primary prey resource for salmonids and many other species. The complexity of interactions among biota dependent on the nearshore zone means restoration benefits are needed across each strategy.

Because outputs from sites of one strategy are not directly comparable to outputs from sites of the other three strategies, and to ensure that at least one alternative plan includes sites from each strategy, alternative plans were generated through a multi-step process:

- First, the sites were organized into four subgroups, one for each strategy (see section 4.5.1).
- Second, IWR Planning Suite (certified version 2.0.6.0) was used to generate an initial array of alternative plans comprised of all possible combinations of sites within each strategy. Based on this evaluation, one or more cost effective sites within each strategy were carried forward (described in section 4.5.2).
- Third, IWR Planning Suite was used to generate a focused array of alternative plans comprised of all possible combinations of the sites across all strategies carried forward from the previous step. Based on this evaluation, a focused array of 23 best buy plans (including the No-Action plan) was identified (described in section 4.5.3).
- Finally, a final array of four alternatives was carried forward. Alternatives 2 and 3 are comprised of multiple sites and address all three of the study's objectives and all four of the study's strategies (described in section 4.5.4). Alternative 4 addresses only 1 objective (deltas) and the No-Action Alternative addresses none of the strategies.

The following sections provide a more detailed explanation of this process and the alternative plans selected as a result.

4.4.1 By-Strategy Subgroups

After estimating costs and benefits, the sites were grouped by the strategy they most prominently addressed. This step ensured that sites addressing each of the four strategies (and by extension all planning objectives) would ultimately be included in the implementation strategy, because the cost effective plans from each strategy were carried forward into the initial array of alternatives. The sites were grouped by strategy as shown in Table 4-4 and summarized below.

River Delta Strategy (9 sites; 12 site designs)

- Big Quilcene Partial
- Deepwater Slough Partial
- Duckabush Full
- Duckabush Partial
- Everett Marshland Full
- Everett Marshland Partial
- Milltown Island Partial
- Nooksack River Delta Partial
- North Fork Skagit Delta Full
- Spencer Island Partial
- Telegraph Slough Full
- Telegraph Slough Partial

Beach Strategy (3 sites; 4 site designs)

- Beaconsfield Feeder Bluff Full
- Beaconsfield Feeder Bluff Partial
- Twin Rivers Partial
- WDNR Budd Inlet Beach Full

Barrier Embayment Strategy (4 sites; 5 site designs)

- Big Beef Creek Estuary Full
- Dugualla Bay Partial
- Livingston Bay Full
- Livingston Bay Partial
- Point Whitney Lagoon Full

Coastal Inlet Strategy (8 sites; 10 site designs)

- Chambers Bay Full
- Chambers Bay Partial
- Deer Harbor Estuary Full
- Harper Estuary Full
- Harper Estuary Partial
- Lilliwaup Partial
- Sequalitchew Full
- Snow/Salmon Creek Estuary Partial
- Tahuya River Estuary Full
- Washington Harbor Partial

4.4.2 Initial Array of Alternatives

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within each of the four strategies described above. This approach was taken due to the software limitations of IWR Planning Suite; because of the large number of combinations of alternative plans that could occur if all 31 site designs at 24 sites were analyzed together, the IWR Plan software application was run four times, once for each strategy.

Each run of IWR Planning Suite identified an initial array of cost effective and best buy alternatives comprised of one or more sites within each strategy. For these runs of IWR Planning Suite, all sites within each strategy were identified as combinable with the exception of the sites that had multiple scales (full and partial). This approach ensured that the initial array of alternatives only included a single scale (full or partial) at each site. No sites were dependent on any other sites.

Through comparison of incremental costs and benefits of the best buy plans for each strategy, the PDT identified the sites within each strategy that made sense for inclusion in the next step of alternative formulation and evaluation using the process outlined in ER 1105-2-100 for identification of a NER plan. For each of the four IWR Plan software runs (one for each strategy), the Study team evaluated costs per output for each plan to determine whether it was

"worth it" in terms of costs and outputs to carry forward the next cost effective increment. Based on this analysis, one or more plans were identified to be carried forward to the next step of the alternatives formulation process, while some plans were not carried forward due to exceptionally high incremental costs per unit.

An example outcome of this step is provided in Figure 4-4 where alternative plans for the coastal inlet strategy are graphed according to their incremental costs and outputs. The Economics Appendix F contains the tables and associated information for the other three strategies.

For the coastal inlet strategy, the eighth plan was selected for inclusion in the next step of formulation and evaluation. This plan was selected in part due to the substantial incremental cost increase that occurs between coastal inlet plans 8 and 9 ($1,577,000 to $8,603,000). Coastal inlet plan 9 includes the Sequalitchew site, with an incremental cost of $7,743,000 for 0.9 AAHU's. Coastal inlet plan 8 includes 7 coastal inlet sites that were carried forward.

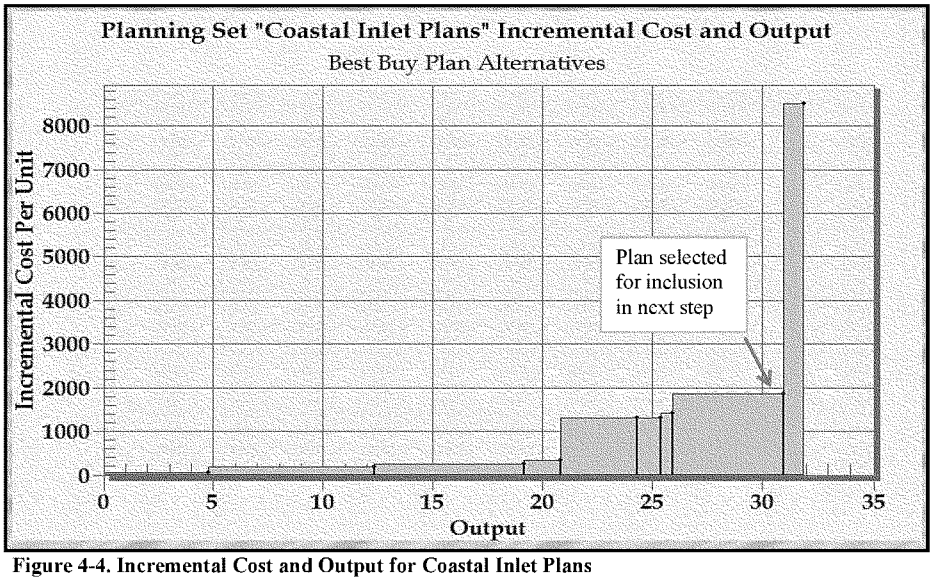


Figure 4-4. Incremental Cost and Output for Coastal Inlet Plans

A similar process was completed for the other three strategies, leading to the inclusion of four barrier embayment sites, eight river delta sites, and three beach sites (in addition to the four coastal inlet sites) for a total of 22 sites. Additional information about the evaluation of best buy plans for each strategy is presented in section 4 of the Economics Appendix. These sites were carried forward individually (versus part of a single, inseparable plan for each strategy) for the next step in the alternatives evaluation process.

4.4.3 Focused Array of Alternatives

IWR Planning Suite was used to generate a focused array of alternative plans comprised of all possible combinations of the 22 sites carried forward from the previous step. This analysis identified 23 best buy alternative plans that contain one or more sites and address one or more strategies. The 23 best buy plans are shown in Table 4-5 along with the associated average annual cost per output and incremental cost per output for each best buy plan. Each plan builds on the previous plan. Beginning with plan number 2, Milltown Island Partial is the only site included in this alternative. Plan number 3 includes Milltown Island Partial plus Deepwater Slough Partial, and plan number 4 includes those two plus Spencer Island Partial. This pattern continues until Chambers Bay Full is added to create the most expensive, highest output plan, plan number 23, which includes 22 sites. The last site added is the site with the highest incremental costs per output. Plans highlighted in green on Table 4-5 were carried forward to the final array of alternatives (described in section 4.4.4).

Table 4-5. Incremental Cost Analysis of Best Buy Plans (Oct 2011 price level)

Plan No.	Plan Name	Average Annual Output (HU)	Average Annual Cost ($1000)	Average Cost / Output ($1000/HU)	Incremental Output (HU)	Incremental Cost ($1,000)	Incr. Cost Per Output ($1,000)
1	No Action	0.0	$0	$0	0.0	$0	$0
2	Milltown Island Partial	64	$198	$3.1	64	$198	$3.1
3	plus Deepwater Slough	154.2	$508	$3.3	90.2	$310	$3.4
4	plus Spencer Island Partial	290.2	$1,295	$4.5	136	$787	$5.8
5	plus Livingston Bay	330.7	$1,856	$5.6	40.5	$561	$13.9
6	plus Dugualla Bay	493.3	$5,221	$10.6	162.6	$3,365	$20.7
7	plus Nooksack Delta Partial	1143.8	$19,353	$16.9	650.5	$14,132	$21.7
8	plus Telegraph Slough Full	1397.7	$28,132	$20.1	253.9	$8,779	$34.6
9	plus Everett Marshland Full	1747	$44,776	$25.6	349.3	$16,644	$47.6
10	plus N. Fork Skagit River Delta	1800.7	$47,774	$26.5	53.7	$2,998	$55.8
11	plus Deer Harbor Estuary	1805.5	$48,085	$26.6	4.8	$311	$64.8
12	plus Beaconsfield Bluff Partial	1806.8	$48,226	$26.7	1.3	$141	$108.5
13	plus Tahuya River Estuary	1814.4	$49,572	$27.3	7.6	$1,346	$177.1
14	plus Big Beef Creek Estuary	1822.3	$51,091	$28.0	7.9	$1,519	$192.3
15	plus Duckabush Delta Partial	1834.6	$53,810	$29.3	12.3	$2,719	$221.1
16	plus Point Whitney Lagoon Full	1836.6	$54,253	$29.5	2	$443	$221.5
17	plus Snow/Salmou Creek Partial	1843.4	$56,013	$30.4	6.8	$1,760	$258.8
18	plus Harper Estuary Full	1845.1	$56,582	$30.7	1.7	$569	$334.7
19	plus WDNR Budd Inlet Beach	1846.2	$57,028	$30.9	1.1	$446	$405.5
20	plus Twin Rivers Partial	1846.4	$57,286	$31.0	0.2	$258	$1,290.0
21	plus Lilliwaup Partial	1847.5	$58,711	$31.8	1.1	$1,425	$1,295.5
22	plus Washington Harbor Partial	1848.1	$59,533	$32.2	0.6	$822	$1,370.0
23	plus Chambers Bay Full	1856.6	$72,941	$39.3	8.5	$13,408	$1,577.4

Note: Plans highlighted in green were carried forward to the final array of alternatives (described in section 4.4.4).

Figure 4-5 shows the incremental cost analysis results graphically. As shown in Table 4-5 and Figure 4-5, the incremental average annual cost per output ranges from a low of $0 per output to $1,577 per output. The first 11 plans range in incremental average annual cost per output from $0 per output to $109 per output, while the next seven plans range in incremental average annual cost per output of $177 per output to $406 per output. A significant increase in cost per output occurs between plans 19 and 20 where the incremental cost per output increases from $406 per output to $1,290 per output. Figure 4-5 shows the incremental cost analysis graphically and indicates the two action alternatives that have been selected for final evaluation and consideration for the Tentatively Selected Plan (TSP), which are listed in Table 4-5 as plan number 12 and plan number 19.

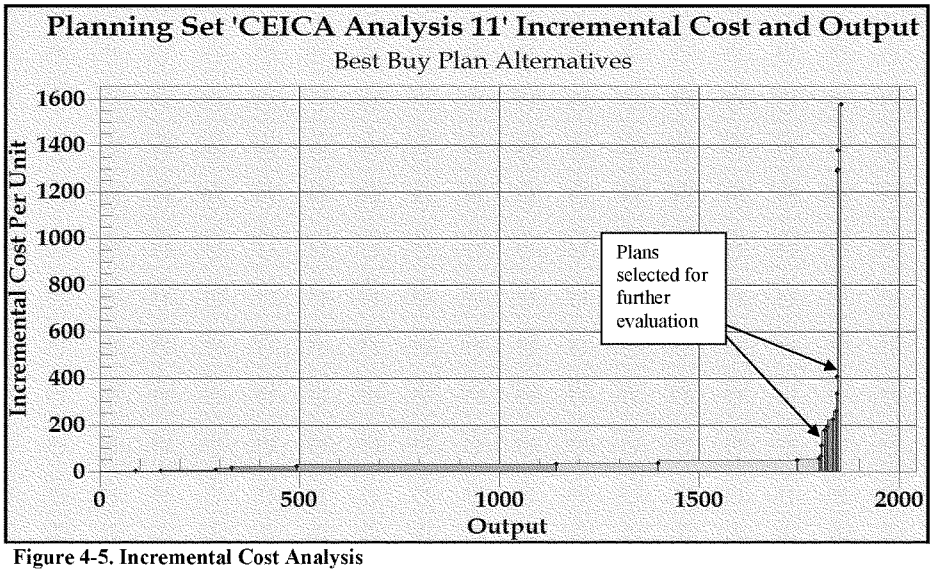


Figure 4-5. Incremental Cost Analysis

4.4.4 Final Array of Alternatives

After reviewing the analyses described above, the PDT identified a final array of three best buy alternatives and one non-best buy alternative to carry forward for final evaluation, comparison, and selection of the TSP. The plans selected for inclusion in the next step of the process are Plan 1, the No-Action Plan; Plan 12, which includes 11 sites; and Plan 19, which includes 18 sites. A fourth alternative not included in the CE/ICA analysis was carried forward based on the results of the implementation master plan development described in section 4.5.

Plans 2 through 10 were not carried forward because they do not address all four restoration strategies (river deltas, beaches, barrier embayments, and coastal inlets). Because the Nearshore

Study aims to recommend a comprehensive restoration plan that addresses ecosystem degradation across different habitat types and sub basins, these alternatives were not carried forward for further analysis or evaluation.

Plan 12 was carried forward in the final array because it is the first alternative that addresses all four restoration strategies, including beaches. Bluff-backed beaches are a key component of the sediment transport process in the nearshore zone, which is why the Beaconsfield site was carried forward.

Plans 13 through 18 were not carried forward in the final array of alternatives; the next plan carried forward for additional analysis was Plan 19. Plan 19 was selected due to the significant increase in incremental cost/output that occurs between Plan 19 and 20 (from $406/output to $1,290/output), as well as the study team's desire to evaluate a plan that, to the fullest extent possible, takes advantage of identified opportunities to implement cost-effective, high-quality restoration. Compared to Plan 12, Plan 19 contains three additional coastal inlet sites, two additional barrier embayment sites, one additional beach site, and one additional river delta site.

While Plans 20 through 23 have noteworthy environmental benefits, the incremental cost/output increases significantly for each of these plans. Although these plans would more completely address the broad restoration needs in the study area, it was determined that the proposed Federal investment of these plans is not justifiable and viable from a cost perspective.

Finally, one additional alternative was carried forward in the final array. As described in section 4.5, three sites are being recommended for construction authorization in a Chief's Report as part of the Puget Sound Nearshore implementation master plan. While this three-site alternative was not evaluated using the standard CE/ICA process summarized in previous sections of this report, it is comprised of a subset of sites included in Plan 19, which was found to be cost effective. This plan was carried forward in the final array of alternatives for additional evaluation, comparison, and trade-off analysis.

A summary of the final array of four alternatives is included below. Formal evaluation and comparison of these alternatives is presented in Sections 4.6 and 4.7.

No-Action Alternative

The No-Action Alternative is synonymous with the "Future Without-Project Condition." The assumption for this Alternative is that no project would be implemented by the Corps to achieve the planning objectives.

Alternative 2 (referenced as Plan 12 above)

Eleven sites were selected for Alternative 2. These sites address all four of the Nearshore Study strategies and are geographically representative of the entire study area (Figure 4-6). Sites included in Alternative 2 are the following:

- Beaconsfield Feeder Bluff
- Deepwater Slough
- Deer Harbor Estuary
- Dugualla Bay
- Everett Marshland
- Livingston Bay
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta
- Spencer Island
- Telegraph Slough

Alternative 3 (referenced as Plan 19 above)

Eighteen sites were selected for Alternative 3. Similar to Alternative 2, the sites included in Alternative 3 address all four of the Nearshore Study strategies and are geographically representative of the entire study area (Figure 4-6). Sites included in Alternative 3 are the following:

- Beaconsfield Feeder Bluff
- Big Beef Creek Estuary
- Deepwater Slough
- Deer Harbor Estuary
- Duckabush River Estuary
- Dugualla Bay
- Everett Marshland
- Harper Estuary
- Livingston Bay
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta
- Point Whitney Lagoon
- Snow Creek and Salmon Creek Estuary
- Spencer Island
- Tahuya River Estuary
- Telegraph Slough
- WDNR Budd Inlet Beach

Alternative 4

Three sites were selected for Alternative 4. These sites were selected based on the recommendations included in the implementation master plan described in section 4.5. Sites included in Alternative 4 include the following:

- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

Figure 4-6 shows the geographic locations of the sites included in the final array of alternatives.

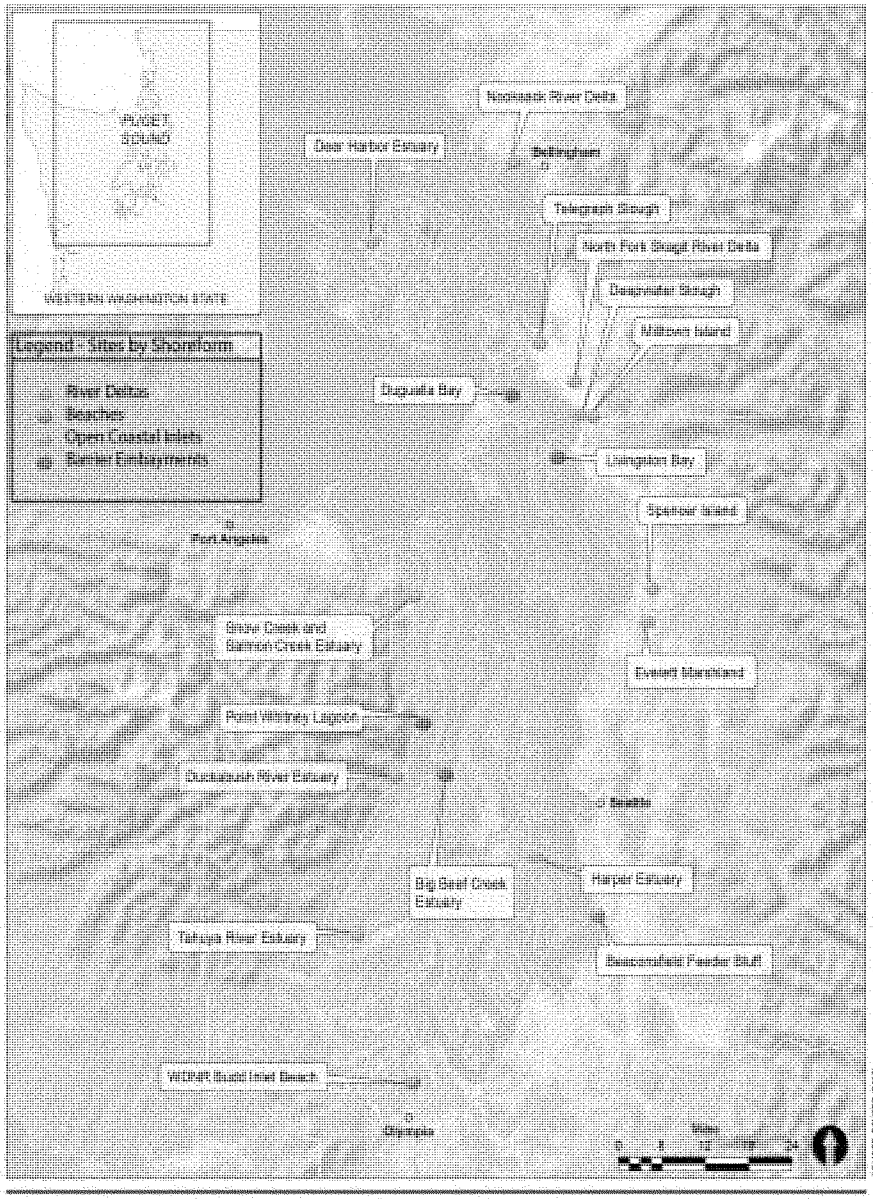


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Figure 4-6. Geographic Locations of the Sites included in the Final Array of Alternatives

4.5 LEVEL 5: DEVELOP IMPLEMENTATION MASTER PLAN

Level 5 of the plan formulation strategy was the development of a master plan for implementing the 36 sites identified under the Level 3 evaluation. After the Level 4 evaluation was completed, a draft integrated Feasibility Report and Environmental Impact Statement (FR/EIS) was released for public review and comment in 2014. That draft report evaluated the final array of three alternatives formulated in Level 4, including the No-Action Alternative, Alternative 2 (11 sites) and Alternative 3 (18 sites). The draft FR/EIS identified Alternative 2 as the tentatively selected plan. Alternative 2 had a preliminary cost estimate of $1.1 billion.

Based on comments received on the draft FR/EIS during concurrent public, technical, and policy review, the study team coordinated efforts to revisit the overall ecosystem restoration strategy for Puget Sound. To reexamine study objectives and potential projects to be recommended for implementation, a workshop was convened in April 2015 with participation from the Corps Seattle District, Northwestern Division, and Headquarters offices, the non-Federal sponsor (Washington State Department of Fish and Wildlife), National Marine Fisheries Service, and the office of the Assistant Secretary of the Army for Civil Works. The objectives of that workshop were to do the following:

1. Reach agreement on criteria for prioritizing ecosystem restoration project sites for implementation under Corps of Engineers missions and authorities in the Puget Sound Nearshore study area;
2. Identify and select priority restoration project sites for Corps implementation;
3. Develop a strategy for project implementation involving the various Corps authorities and Programs; and,
4. Establish and agree on a path forward for completion of the Nearshore study and expeditious transition to project implementation consistent with national budgetary priorities and with the plan formulation and evaluation conducted to date.

As an outcome of the workshop, a tiered implementation approach was developed for those project sites deemed critical to comprehensively restore the ecological function of the Puget Sound Nearshore, including connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. Referred to as the "Master Plan" for Puget Sound Nearshore Ecosystem Restoration, The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities of the Corps and Puget Sound Nearshore partners. It was determined that the workshop would focus on the group of 36 sites formulated in Level 3 because that tier included formulation of a range of multiple conceptual site designs for all sites (72 total plan) that represent opportunities for comprehensive restoration of all four restoration strategies (beaches, coastal embayments, coastal inlets, and large river deltas). Site benefits and costs had been developed for all 36 sites.

Various approaches were considered for implementation of each of the group of 36 project sites. Those approaches included:

1. Continued formulation and evaluation of sites to ultimately seek authorization and implementation through the Corps General Investigations (GI) Program;
2. Implementation through existing Corps construction authorities under the Continuing Authorities Program (CAP). Existing CAP authorities include the Section 206 and 1135 authorities, both of which authorize the Corps to construct small-scale riparian and aquatic habitat restoration projects;
3. Implementation through the Corps Puget Sound and Adjacent Waters Program (PSAW), a standing authority that allows the Corps to implement small-scale aquatic habitat restoration program in the Puget Sound Region; and,
4. Projects to be completed by others using programs and authorities outside of Corps participation.

A number of qualitative criteria were evaluated to categorize the group of 36 sites into the appropriate implementation approaches described above, including:

- Estimated project costs: Smaller sites (i.e., estimated costs less than $20 million) were generally identified as implementable under CAP or PSAW, while sites with estimated costs greater than $20 million were identified as more appropriate to carry forward under the GI program or be implemented by others. For example, the estimated project cost for WDNR Budd Inlet Beach is approximately $10 million, leading the team to recommend site for implementation under CAP.

- Restoration potential: Sites were evaluated based on relative restoration benefits and costs (Ecosystem output, score, type of habitat restored, and location of restoration) and overall restoration potential.

- Lands and real estate considerations: Sites were evaluated based on availability of lands as well as amount of lands, easements, rights of way, or relocations required for the project. Evaluation of this criteria included an assessment of whether sites have land already in public ownership or whether sites have large relocation requirements.

- Overall readiness to proceed: Considerations of community endorsement, broader regional endorsement, and tribal support assisted the team in determining whether sites were suitable to move forward in the near-term or require additional coordination before site-specific analysis occurs. For example, a number of public comments related to proposed restoration at Everett Marshland led the team to recommend this site for further study under the GI program, allowing for additional coordination with local landowners and community stakeholders.

- Corps policy considerations: Some sites were identified as having outstanding policy concerns that will require additional coordination and analysis before being recommended for construction.

- Finally, 12 sites were identified where restoration work is complete, underway, or will soon be underway by others. These sites were categorized under the "projects to be completed by others" category in the master plan. For example, restoration at Deer Harbor is being carried forward by a local project proponent, leading the team to identify this as a site to be completed by others.

The implementation master plan identifies three sites recommended for construction authorization. Nine sites are recommended for further feasibility study, including additional NEPA analysis. The master plan also identifies 12 sites that will have additional study under CAP or PSAW and 12 sites that will be completed without Corps involvement. Table 4-7 identifies all 36 sites and the implementation categories that they have been placed under in the Master Plan.

The three sites recommended for initial authorization under this feasibility study include: (1) the Duckabush River Estuary; (2) the North Fork Skagit River; and, (3) the Nooksack River Delta. Each of those sites was previously evaluated under the Level 3 analysis. The North Fork Skagit and Nooksack River Delta sites were both included in Alternative 2 under the Level 4 analysis. However, to ensure consistency with NEPA requirements for full disclosure of all alternatives under consideration, these three sites are now grouped as Alternative 4 and described in more detail in the Level 6 evaluation that follows.

In summary, the primary driving rationale for selecting these three projects sites to move forward with as the priority projects under this feasibility study is as follows:

- The workshop participants made a conscious decision to focus current efforts on restoring river deltas. The projects under this category tend to be large-scale projects requiring restoration of natural hydraulic function, consistent with the Corps mission for ecosystem and expertise.

- The Nooksack River Delta currently has the least development and infrastructure of any of the large river deltas in Puget Sound and opportunity exists now to take advantage of that lack of development to restore a large portion of the estuary before further change occurs limiting that potential. Restoration of the Nooksack River Delta would provide 25 percent of the Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project.

- The Duckabush River Estuary is primarily in public ownership, allowing restoration to occur without acquisition of large-scale real estate interests and with the support of public

agencies. The Duckabush site is located within Hood Canal and is a critical location for restoring the habitat and populations of Summer Chum Salmon. The benefits associated with restoring Hood Canal estuary habitat has been identified as a critical area for the restoration of the Puget Sound.

- The North Fork Skagit River is critically important to all five species of Pacific salmon as well as steelhead and sea-run cutthroat trout. Habitat productivity in the headwaters of this river is high due to the large extent of wilderness protection. However, the lower reaches of the river are highly degraded. This site near the delta provides an opportunity to restore large areas of natural habitat components critical for the life-history of salmonids and other species.

Chapter 6 of this report describes the three sites included in the recommended plan in more detail. Appendix K of this report includes more information about the nine sites identified for additional study. Table 4-6 identifies all 36 sites and the implementation categories that they have been placed under in the Master Plan.

Table 4-6. Implementation Master Plan

General Investigation: Chief's Report	General Investigation: Additional Study	Continuing Authorities Program: Section 206	Puget Sound and Adjacent Waters: Section 544	Projects to be Completed by Others
• Duckabush River Estuary • Nooksack River Delta • North Fork Skagit River Delta	• Big Beef Creek Estuary • Big Quilcene River • Chambers Bay • Dugualla Bay • Everett Marshland • Lilliwaup River Estuary • Snohomish River Estuary • Tahuya River Estuary • Telegraph Slough	• Chuckanut Estuary • Deepwater Slough • Everett Riverfront Wetland • Harper Estuary • Livingston Bay • McGlinn Island • Sequalitchew Creek • WDNR Budd Inlet Beach	• Quilceda Estuary • Spencer Island • Twanoh Beach • Twin Rivers	• Beaconsfield Feeder Bluff • Deer Harbor • Deschutes River Estuary • Hamma Estuary • Johns Creek Estuary Restoration • Kilisut Harbor/Oak Bay • Milltown Island • Mission Creek • Point Whitney Lagoon • Smith Island • Snow Creek and Salmon Creek Estuary • Washington Harbor

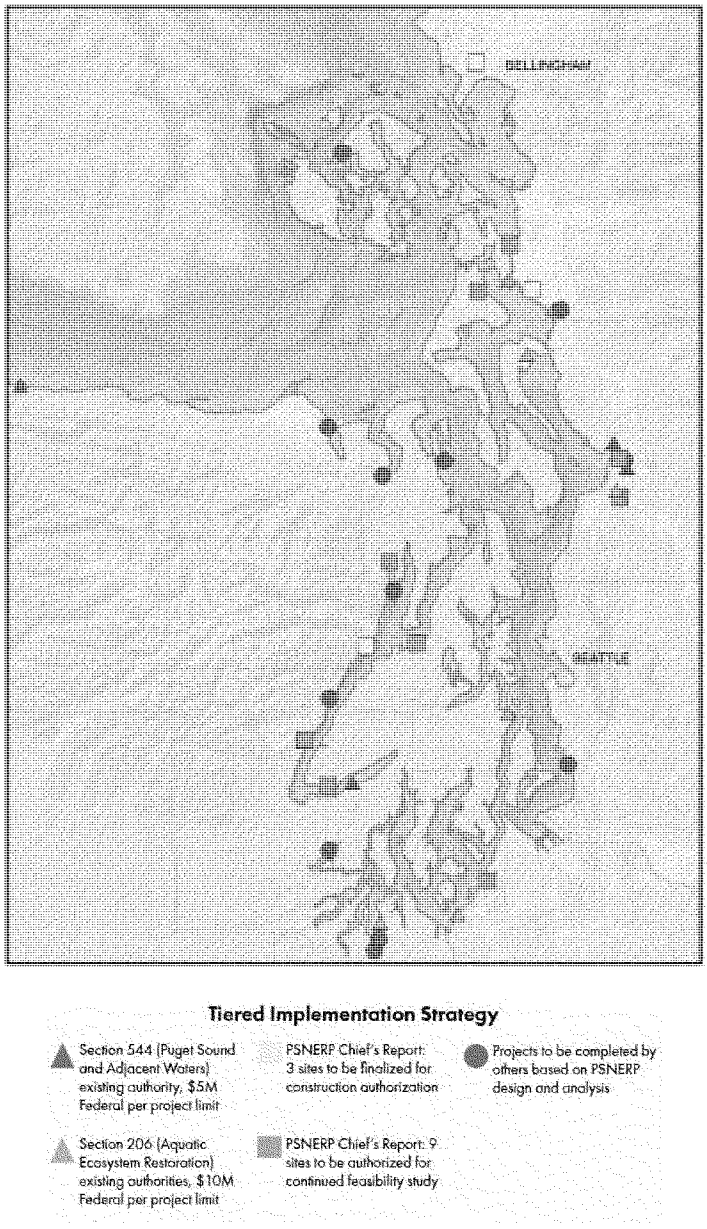


Figure 4-7. Master Plan: Tiered Implementation Strategy

4.6 LEVEL 6: SITE IMPLEMENTATION ANALYSIS – EVALUATION OF FINAL ARRAY OF ALTERNATIVES

Level 6 of the plan formulation strategy included site-specific implementation analysis and evaluation of the final array of alternatives. As initially presented in section 4.5.4, the Nearshore Study team selected a final array of four alternatives. In addition to the No-Action Alternative, Alternative 2 includes 11 sites while Alternative 3 includes 18 sites. Alternative 4 includes three sites. The alternatives are described below in more detail.

It should be noted that the tiered strategy for implementation of all 36 sites (described in section 4.5) allows for a more diversified scope of projects to be implemented under various restoration authorities and partners. Although the following sections evaluate and compare the final array of four alternatives for the purposes of this report, there are broad restoration benefits associated with the larger, 36-site master plan.

Table 4-7. Summary of Final Array of Alternatives

Site Name	Alternative 1 No-Action	Alternative 2 11 Sites	Alternative 3 18 Sites	Alternative 4 3 Sites	Strategy	EO Score (AAHU)	Acreage	Proposed Action
Deepwater Slough		X	X		River Delta	90.2	25.5	Lower existing dikes to grade. Excavate breaches to reconnect tidal channels. Remove a temporary bridge between the islands.
Everett Marshland		X	X		River Delta	349.3	829.1	Remove dikes along the Snohomish River; construct new dikes to maintain existing level of flood risk management. Fill agricultural ditches and reconstruct tidal channels. Reconnect surrounding streams to restored area. Upgrade railway bridges to allow for tidal exchange.
Milltown Island		X	X		River Delta	64	214.2	Breach west perimeter dikes in three locations. Create pilot channels associated with breach locations.
Nooksack River Delta		X	X	X	River Delta	166.32	1807	Breach and/or remove dikes along both sides of the Nooksack and Lummi Rivers; construct new levees to maintain existing level of flood risk management. Install log jams in Nooksack River. Partial restoration of river flow to Lummi River through installation of water control structure at confluence of Lummi and Nooksack Rivers; structure intended to facilitate transfer of freshwater and sediment to the Lummi River. Channel creation and rehabilitation on the Lummi River. Remove several filled causeways and replace with wide span bridges to allow for tidal exchange.
North Fork Skagit River Delta		X	X	X	River Delta	53.69	256.1	Lower and breach dikes; construct new dikes to maintain existing level of flood risk management. Excavate tidal channel network. Remove shore armor and other hardened surfaces and infrastructure.
Spencer Island		X	X		River Delta	136.0	313.2	Lower dikes adjacent to Steamboat and Union Sloughs. Expand existing breaches on the eastern and northern dikes and breach the western dike. Retain public access by constructing a replacement pedestrian bridge over new breach site.
Telegraph Slough		X	X		River Delta	253.9	932.2	Construct a bridge at State Route 20 and BNSF railroad over Telegraph Slough, raise these causeways west of Swinomish Slough to allow for tidal exchange. Excavate channel to connect distributary channels to Padilla Bay. Remove tidal dikes and Swinomish Channel Dike; construct new dike to maintain existing level of flood risk management. Remove old culverts and tidegates and install new culverts and tide gates.
Duckabush River Estuary			X	X	River Delta	12.3	38	Replace the Highway 101 causeway with a widespan bridge to allow full tidal flushing. Remove fill from Shorewood Road and adjacent areas. Reestablish tidally influenced distributary channels. Excavate channels within the marsh areas.

Site Name	Alternative 1 No-Action	Alternative 2 11 Sites	Alternative 3 18 Sites	Alternative 4 3 Sites	Strategy	EO Score (AAHU)	Acreage	Proposed Action
Dugualla Bay		X	X		Barrier Embayment	162.6	572	Remove roadway berm/dike and associated fill and replace with a widespan bridge to allow full tidal exchange. Excavate new tidal channel opening at Dike Road. Remove dikes and armoring and install culverts. Fill linear drainage ditches throughout site. Remove structures on acquired properties within area of proposed tidal flooding. Restore shoreline on east side of Dike Road.
Livingston Bay		X	X		Barrier Embayment	41.6	244.6	Lower dikes to existing grade; construct new dike to maintain existing level of flood risk management. Excavate new tidal inlet through breach; excavate tidal channels and starter channels. Remove fill to reestablish tidal inlet at its historic location. Remove small pump station and associated utilities. Nourish beach with excavated tidal inlet material.
Big Beef Creek Estuary			X		Barrier Embayment	8.5	91	Remove fill and armor associated with Seabeck Highway causeway. Replace current bridge with a widespan bridge across the embayment inlet and spit to allow full tidal exchange at Big Beef Creek Estuary. Restore tidal channel landward of the new bridge and around the spit.
Point Whitney Lagoon			X		Barrier Embayment	2.0	6.1	Remove all pond dikes and associated culverts, tide gates, and other infrastructure. Remove rock revetments, fill, and pavement on the spit. Placement of beach gravel on the lower elevations of the eastern portion of the spit. Remove all buildings and other structures in nearshore areas.
Beaconsfield Feeder Bluff		X	X		Beach	2.2	6.9	Remove approximately 800 feet of shoreline armoring. Minor regrading to recreate a gently sloping upper intertidal beach.
WDNR Budd Inlet Beach			X		Beach	1.1	2.0	Remove bulkheads and fill. Remove buildings, timber piles, and debris. Dredge to recreate tidal lagoon and excavate tidal channel to connect tidal lagoon with nearshore zone. Restore barrier beach and natural beach profile.
Deer Harbor Estuary		X	X		Coastal Inlet	4.8	16.1	Remove Channel Road bridge; remove associated embankment armor and fill. Construct a new bridge to allow full tidal flushing at the mouth of the inlet. Remove sediments at inlet. Remove nearshore debris (riprap and rock slope protection).
Harper Estuary			X		Coastal Inlet	1.7	6.2	Remove a portion of SE Olympiad Drive. Remove roadway embankment and armoring on the eastern side of the estuary. Remove fill and other debris from the estuary. Excavate a more sinuous stream channel and starter channels.

4.6.1 Alternative 1 – No-Action Alternative

This alternative is included for comparison purposes and represents future conditions without implementation of a large-scale Federal restoration project. Degradation trajectories would continue as influenced by development and existing restoration and protection authorities. Small-scale restoration requiring extensive local and state funding not supported by large-scale Federal investment would continue based largely on an opportunistic approach. Funding of restoration and protection would continue at funding levels and spatial scales already determined feasible by local entities.

4.6.2 Alternative 2 – Restore 11 Sites

4.6.2.1 *Geographic Locations*

Alternative 2 includes 11 sites. The majority of these 11 sites are focused around the Skagit and Snohomish River Deltas, with one site on the stretch of shoreline between Tacoma and Seattle (Beaconsfield) and one to the north in the San Juan Islands (Deer Harbor). These 11 sites represent the minimum restoration action required to make progress toward the four restoration strategies defined by the Nearshore Study. Sites are distributed in four of the seven Puget Sound sub-basins defined by the Nearshore Study (Figure 1-1), with eight of the 11 sites located in one sub-basin (Whidbey). The western portion of Puget Sound (including Hood Canal and the Strait of Juan de Fuca) as well as the South Puget Sound are not represented in this alternative.

4.6.2.2 *Restoration Sites Included*

Alternative 2 includes 11 of the 18 sites described in section 4.5.4. Sites included in this alternative range in size from six to 1,807 acres and include the following:

The seven large river delta sites selected for this alternative, ranging in size from 214 to 1,807 acres, include the following:

- Deepwater Slough
- Everett Marshland
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta
- Spencer Island
- Telegraph Slough

Only one site has been selected to address the open coastal inlet strategy and the associated focus on restoring tidal hydrology and freshwater input processes. This site is 16 acres:

- Deer Harbor Estuary

The barrier embayment strategy would be addressed at two sites, where the restoration of tidal hydrology is required, as well as reestablishment of a stable barrier beach to provide necessary low-energy conditions. The sites range from 239 to 572 acres and include the following:

- Dugualla Bay
- Livingston Bay

Only one cost-effective site has been identified to address beach strategy target processes of restoring sediment supply and transport. While the team evaluated several potential sites, most did not appear to meet the identified restoration requirement to restore sediment delivery processes, typically by the removal of shoreline armoring. This site is relatively small at six acres of area of restored process, but it remains ecologically significant:

- Beaconsfield Feeder Bluff

4.6.2.3 *Construction Costs*

The 11 sites that comprise Alternative 2 have a total first cost of approximately $1,063,899,000 (October 2011 price level). The average annual cost for Alternative 2 over the 50-year period of analysis is approximately $48,226,000.

4.6.2.4 *Ecosystem Benefits*

Benefits of this alternative would derive from removing nearly 75,162 linear feet of shoreline stressors, thereby restoring processes that would create 5,348 acres of tidally influenced wetlands in river deltas and shallow embayments; as well as sustain two beaches. Benefits to salmonids and forage fish would primarily focus on populations in the Snohomish and Skagit basins. Eight of the 11 sites are used for spawning and/or rearing and restoration will allow access at an additional three sites. Six of the 11 sites have documented or potential forage fish spawning within close proximity. Additionally, predators throughout the Puget Sound would benefit as these prey species disperse during the ocean portion of their lifecycle.

ESA-listed species in Puget Sound that have suffered from a loss or degradation of habitat would benefit from the removal of shoreline stressors at these 11 sites, either directly by using the restored habitat (as is the case for listed salmonids) or indirectly via reliance of their prey on the habitat (as is the case for killer whales and murrelets). Benefits to ESA-listed species would be similar to those discussed for Alternative 3, but to a lesser extent due to fewer stressors removed and associated habitat restored, and the limited geographic range of the proposed sites. Hood Canal salmon, eulachon, and green sturgeon would see little benefit since there are no sites in Hood Canal and only one in northern Puget Sound (where eulachon and Green sturgeon occur). ESA-listed species that would benefit from this alternative include Chinook salmon, bull trout, steelhead, and juvenile rockfish, and the predators that rely on them or other nearshore zone dependent species (killer whales and marbled murrelet).

Restored sediment transport and delivery to beaches and embayments will support ecologically valuable kelp and eelgrass beds (six of the 11 sites have eelgrass and/or kelp beds within close proximity). These beaches, shallow embayments, and kelp and eelgrass beds will provide refuge habitat for juvenile salmonids during shoreline migration, spawning substrate for forage fish (five of the 11 sites have documented or potential forage fish spawning within close proximity), and three-dimensional habitat for a variety of fish and invertebrates including juvenile rockfish, clams, and crabs. The restored wetlands in large river deltas and coastal embayments, and their associated tidal channels, would be colonized by native plants and invertebrates, resulting in critical rearing and foraging habitat for juvenile salmonids.

The additions and improvements of nearshore habitat would increase Puget Sound's shoreline complexity, diversity, and connectivity providing a variety of habitat types and ecological niches for many nearshore species that play key roles in the Puget Sound food web, as well as provide ecosystem functions like nutrient cycling and water purification. These benefits would ascend trophic levels yielding prey for many bird species such as great blue herons, dunlins, and bald eagles that use nearshore wetlands and beaches to forage, as well as marine mammals.

4.6.3 Alternative 3 – Restore 18 Sites

4.6.3.1 *Geographic Locations*

The 18 sites included in this alternative are geographically diverse. These sites range from the Nooksack River estuary in northern Puget Sound to the WDNR Budd Inlet beach in the South Sound, as well as three sites in Hood Canal, one in Discovery Bay on the Strait of Juan de Fuca, and several sites in between. Sites are distributed in six of the seven Puget Sound sub-basins defined by the Nearshore Study. The exception is the North Central Puget Sound sub-basin, which is small with limited restoration opportunities compared to other sub-basins (Figure 1-1).

4.6.3.2 *Restoration Sites Included*

All 18 sites described in section 4.5 are included in this alternative. This alternative includes eight sites addressing delta strategy target processes such as tidal and freshwater flow. The sites range in size from two to 1,807 acres. (*Indicates sites not included in previous 11-site alternative.)

The eight large river delta sites selected for this alternative, ranging in size from 38 to 1,807 acres, include the following:

- Deepwater Slough
- Duckabush River Estuary*
- Everett Marshland
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta
- Spencer Island
- Telegraph Slough

Four sites have been selected to address the open coastal inlet strategy and the focus on restoring tidal hydrology and freshwater input processes. These sites range from six to 52 acres:

- Deer Harbor Estuary
- Harper Estuary*
- Snow Creek and Salmon Creek Estuary*
- Tahuya River Estuary*

The barrier embayment strategy would be addressed at four sites, where the restoration of tidal hydrology is required, as well as reestablishment of a stable barrier beach to provide necessary low-energy conditions. The sites range from six to 572 acres and include the following:

- Big Beef Creek Estuary*
- Dugualla Bay
- Livingston Bay
- Point Whitney Lagoon*

Only two cost-effective sites have been identified to address beach strategy target processes of restoring sediment supply and transport. While the team evaluated several potential sites, most did not appear to meet the identified restoration requirement to restore sediment delivery processes, typically by the removal of shoreline armoring. These two sites are relatively small, with two and six acres of area of restored process, but remain ecologically significant:

- Beaconsfield Feeder Bluff
- WDNR Budd Inlet Beach*

4.6.3.3 *Construction Costs*

The 18 sites that comprise Alternative 3 have a total first cost of approximately $1,252,977,000 (October 2011 price level). The average annual cost over the 50-year period of analysis for Alternative 3 is approximately $57,028,000.

4.6.3.4 *Ecosystem Benefits*

Benefits from this alternative would derive from removing approximately 113,094 linear feet of shoreline stressors (most of which are tidal barriers, nearshore fill, and shoreline armoring), thereby restoring processes that would create or restore 5,517 acres of tidally influenced wetlands in river deltas and shallow embayments, as well as sustain a bluff-backed beach and a barrier beach system. These benefits would be distributed among all but one of the sub-basins in Puget Sound (North Central).

Restored sediment transport and delivery to beaches and embayments will support the ecologically valuable kelp and eelgrass beds (12 of the 18 sites have eelgrass and/or kelp beds within close proximity). Refuge habitat for juvenile salmonids will be provided (13 of the 18

sites have documented or potential forage fish spawning nearby), along with critical rearing and foraging habitat for juvenile salmonids (14 of the 18 sites are used by anadromous fish for spawning and/or rearing; restoration will allow for access at the remaining four sites).

The majority of the sites in Alternative 3 would benefit Chinook salmon, steelhead, and bull trout, and three sites would benefit Hood Canal summer chum salmon by providing rearing habitat for juveniles and restoring shoreline processes that sustain beaches and kelp and eelgrass beds for forage fish spawning (a preferred prey item). Benefits to Chinook and chum will indirectly benefit Southern Resident killer whales since they preferentially feed on these species during much of the year. Eulachon would benefit from sites restored in the northern portions of Puget Sound, including the 1,807 acres of restored river delta in the Nooksack Estuary. Species that have not necessarily seen declines in number due to habitat loss in Puget Sound would still benefit from added foraging areas (green sturgeon and Steller sea lions) and rearing habitat (kelp and eelgrass beds for juvenile rockfish).

4.6.4 Alternative 4 – Restore 3 Sites

4.6.4.1 *Geographic Locations*

The three sites included in this alternative are geographically diverse, representing process-based restoration opportunities across the Puget Sound nearshore zone. These sites range from the Nooksack River Delta in northern Puget Sound to the Duckabush River Estuary in Hood Canal. Sites are distributed in three of the seven Puget Sound sub-basins defined by the Nearshore Study (Figure 1-1).

4.6.4.2 *Restoration Sites Included*

This alternative includes three sites addressing delta strategy target processes such as tidal and freshwater flow. The three large river delta sites selected for this alternative, ranging in size from 38 to 1,807 acres, include the following:

- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

4.6.4.3 *Construction Costs*

The three sites that comprise Alternative 4 have a total first cost of approximately $454,269,000 (October 2011 price level). The average annual cost over the 50-year period of analysis for Alternative 4 is approximately $19,849,000.

4.6.4.4 *Ecosystem Benefits*

Benefits from this alternative would derive from removing approximately 28,860 linear feet of shoreline stressors (most of which are tidal barriers, nearshore fill, and shoreline armoring),

thereby restoring processes that would create or restore 2,101 acres of tidally influenced wetlands in river deltas.

Restored sediment transport and delivery to river deltas will support the most biologically diverse habitats in the affected estuaries. Two of the three sites have eelgrass and/or kelp beds immediately downstream. Refuge habitat for juvenile salmonids will be provided along with critical rearing and foraging habitat (all three sites are used by anadromous fish for rearing). Two of the three sites have documented or potential forage fish spawning nearby, and all three sites support waterfowl concentrations.

This alternative removes over five miles of shoreline armoring that inhibits the natural physical processes that support habitat development for the ESA-listed species. This alternative includes the Duckabush River Estuary site in Hood Canal, which would benefit Hood Canal summer chum. Benefits to Chinook and chum will benefit Southern Resident killer whales since they preferentially feed on these species during much of the year. Eulachon would benefit from sites restored in the northern portions of Puget Sound, including the 1,807 acres of restored river delta in the Nooksack Estuary. Species that have not necessarily seen declines in number due to habitat loss in Puget Sound would still benefit from added foraging areas (green sturgeon and Steller sea lions) and rearing habitat (kelp and eelgrass beds for juvenile rockfish).

4.7 LEVEL 6: SITE IMPLEMENTATION ANALYSIS – COMPARISION OF FINAL ARRAY OF ALTERNATIVE PLANS

Level 6 of the plan formulation strategy included a comparison of the final array of alternatives. In this section, the final array of four alternative plans are compared to each other, with emphasis on the outputs and effects that will have the most influence in the decision-making process. Beneficial and adverse effects of each plan are compared including monetary and non-monetary benefits and costs. From this comparison, the tradeoffs between the plans are transparent. This comparison of alternatives is partially a reiteration of the evaluation presented in the previous sections with the exception that the three action alternatives are compared to each other, and not just against the without-project condition (aka the No-Action Alternative). The comparison of the alternatives is presented in terms of planning criteria and evaluation accounts, as well as the effects on significant resources described in detail in Chapter 5.

4.7.1 National Ecosystem Restoration Evaluation

Performance of the alternative plans with respect to the planning objectives appears in Table 4-7 along with additional key evaluation criteria (e.g., cost, acres restored, etc.) to inform the National Ecosystem Restoration (NER) evaluation.

Table 4-7. Planning Criteria Comparison

PLANNING CRITERIA	Alternative 1 No Action	Alternative 2 11 Sites	Alternative 3 18 Sites	Alternative 4 3 Sites
Strategy 1/ Objective 1 - Deltas	0 Sites 0 Acres Net EO[1] = 0[2]	7 Sites 4,521 acres Net EO = 1,598	8 sites 4,559 acres Net EO = 1,609	3 sites 2,101 acres Net EO = 717
Strategy 2/ Objective 2 - Beaches	0 Sites 0 Acres Net EO = 0	1 Site 6 acres Net EO = 1.3	2 Sites 8 acres Net EO = 2.5	0 Sites 0 acres Net EO = 0
Strategy 3/ Objective 3 - Embayments (Barrier Embayments)	0 Sites 0 Acres Net EO = 0	2 Sites 811 acres Net EO = 203.1	4 Sites 847 acres Net EO = 212.9	0 Sites 0 acres Net EO = 0
Strategy 4/ Objective 3 - Embayments (Coastal Inlets)	0 Sites 0 Acres Net EO = 0	1 Site 16 acres Net EO = 4.8	4 Sites 110 acres Net EO = 20.8	0 Sites 0 acres Net EO = 0
Acres of Restored Habitat	0 acres	5,354 acres	5,524 acres	2,101 acres
Net EO (Average Annual Benefits in Habitat Units)	0 EO	1,807 EO	1,846 EO	717 EO
Cost (Average annual at October 2011 price level)	$0	$48,226,000	$57,028,000	$19,849,000
Total Estimated Costs (October 2011 price level)	$0	$1,063,899,000	$1,252,977,000	$454,269,000

Notes: [1] Net EO, Environmental Outputs, is represented by Average Annual Benefits measured in Average Annual Habitat Units (AAHU or HU). [2]For comparative purposes, a 0 Net EO indicates that no action at any sites would have no net increase to ecosystem outputs.

In addition to the National Ecosystem Restoration evaluation presented above, the Principles and Guidelines establish additional accounts to facilitate the evaluation, display, and comparison of the effects of alternative plans. For the Environmental Quality (EQ) account, refer to Table 4-7 above and Table 5-10 for a display of ecological, cultural, and aesthetics attributes. For the Regional Economic Development (RED) account, there is no significant difference expected between the with- and without-project conditions for any alternative. For the Other Social Effects (OSE) account, Alternatives 2, 3, and 4 would all positively affect fish species of concern for many Native American tribes located in Washington State.

4.7.2 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 are used in the formulation, evaluation, comparison, and selection of the recommended plan. The following tables and paragraphs summarize the key trade-offs between Alternatives 2, 3, and 4.

Acreage and Geographic Spread

Alternative #	*Acres Restored*	*Linear Feet of Stressors Removed*	*Geographic Spread: Sub-Basins*
Alternative 2	5,354	77,796 LF	3 of 7 sub-basins
Alternative 3	5,524	115,718 LF	6 of 7 sub-basins
Alternative 4	2,101	28,860 LF	3 of 7 sub-basins

Note: The 36-site master plan restores over 8,000 acres and includes all of the 7 sub-basins.

Complexity of Habitat Types

Alternative #	*# of River Delta Sites*	*# of Coastal Inlet Sites*	*# of Barrier Embayment Sites*	*# of Beach Sites*
Alternative 2	7	1	2	1
Alternative 3	8	4	4	2
Alternative 4	3	0	0	0

Note: The 36-site master plan includes 16 river delta sites, 10 coastal inlet sites, 6 barrier embayment sites, and 4 beach sites.

ESA-Listed Species

All sites in Alternatives 2, 3, and 4 include critical habitat for ESA-listed species. Alternative 3 would benefit more ESA-listed species and would have a greater breadth of benefits compared to the other two alternatives. Alternatives 3 and 4 would provide benefits to Hood Canal salmon including the ESA-listed summer chum, whereas Alternative 2, with no sites in Hood Canal, would not. Similarly, Alternative 3 is more likely to benefit green sturgeon and eulachon, which are only known to forage in the Strait of Juan de Fuca and northern Puget Sound (three sites are located in this area versus only one for Alternatives 2 and 4). Southern Resident killer whales would receive the greatest benefit from Alternatives 2 and 3 due to the inclusion of the Nooksack, Skagit, and Snohomish River Deltas. These sites would improve a substantial amount of habitat for salmon, a major component of the diet of the Southern Resident killer whales.

Principles and Guidelines Evaluation Criteria

Completeness – All sites included in Alternatives 2, 3, and 4 account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs at the scale of each site.

Effectiveness - All sites included in Alternatives 2, 3, and 4 effectively restore the processes that create and sustain Puget Sound nearshore ecosystems at the scale of each site. Alternative 3 is more effective overall than Alternatives 2 or 4 in that it addresses the observed problems at more locations around the sound.

Efficiency – Alternative 2 and Alternative 3 were identified through analysis as cost-effective and best-buy plans using the IWR Plan software. Both are considered to be efficient alternative plans. Alternative 4 was not identified as a best buy plan using the traditional CE/ICA approach;

however, the three sites included in Alternative 4 are components of Alternatives 2 (North Fork Skagit River Delta and Nooksack River Delta) or Alternative 3 (includes Duckabush River Estuary, North Fork Skagit River Delta, and Nooksack River Delta), which were both identified as best buy plans.

Acceptability – Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. Alternatives 2, 3, and 4 are all acceptable based on this definition.

4.8 TENTATIVELY SELECTED PLAN

After the Level 4 evaluation was completed, a draft integrated Feasibility Report and Environmental Impact Statement (FR/EIS) was released for public review and comment in 2014. That draft report evaluated the final array of three alternatives formulated in Level 4, including the No-Action Alternative, Alternative 2 (11 sites) and Alternative 3 (18 sites). The draft FR/EIS identified Alternative 2 as the tentatively selected plan. Alternative 2 had a preliminary cost estimate of $1.1 billion.

4.9 NATIONAL ECOSYSTEM RESTORATION PLAN

The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quality and/or quantity of desired ecosystem resources. As described in section 4.5, a tiered implementation approach was developed for all 36 sites identified across Puget Sound deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and partners. The implementation master plan identifies various approaches for implementation of the 36 projects: GI projects to be recommended for construction, GI projects recommended for additional study, projects to be completed under existing Corps construction authorities (CAP) or Puget Sound and Adjacent Waters Program (PSAW), and projects to be completed by others.

The NER Plan is the 36-site master plan. This plan reasonably maximizes ecosystem restoration benefits and restores over 8,000 acres across all seven Puget Sound sub-basins. The NER Plan includes 16 river delta sites, 10 coastal inlet sites, 6 barrier embayment sites, and 4 beach sites. Implementation of the plan will achieve over 60% of the estuary habitat restoration goals targeted for completion by 2020 in the Puget Sound Action Agenda. The NER Plan also supports five salmon recovery plans and meets all four planning objectives identified for this study.

The implementation strategy allows for the three sites to move forward now because they provide key restoration across three separate areas of the Puget Sound. The additional nine sites recommended for further study ensures a watershed level solution for the most complex, large

scale restoration projects identified as critical for restoring the Puget Sound. Finally, the other 24 sites identified as part of the 36-site master implementation plan are being carried out under other Corps authorities or through non-federal actions and are complementary to achieving the overall study objectives. These can be completed concurrently with the implementation of sites recommended through the General Investigation study process. The NER plan is consistent with restoration objectives for Puget Sound, which is designated as an estuary of National Significance. The NER plan contributes to recovery of endangered species, supports treaty reserved fishing, hunting and gathering areas and contributes significantly to the recovery goals identified in the Puget Sound Action Agenda that was created by the Puget Sound Partnership.

Although this plan was not formally identified using the traditional CE/ICA approach, components of the plan were identified through analysis as cost-effective using the IWR Plan software. The NER Plan is complete, effective, and acceptable. The NER Plan accounts for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs at the scale of each site. It will effectively restore the processes that create and sustain Puget Sound nearshore ecosystems at the scale of each site and is acceptable in terms of applicable laws, regulations, and public policies.

4.10 RECOMMENDED PLAN

The strategic master plan described above and in section 4.5 was developed after the TSP was initially identified. As such, the study team revisited the original plan formulation and evaluation results, ultimately revising the TSP to be consistent with the strategic implementation master plan. Of the 36 sites identified for implementation across Puget Sound, three are being recommended for construction authorization under this existing Corps feasibility study and are presented as the recommended plan, and the agency preferred alternative. The three-site recommended plan is smaller than the 11-site TSP that was originally identified; however, the recommended plan is one aspect of the broader strategy to implement all 36 sites across Puget Sound.

Based on the strategic implementation master plan, Alternative 4 is the recommended plan and agency preferred alternative and includes the following sites:

- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

Restoration at the Duckabush River Estuary would address habitat constraints in Hood Canal, which is a partially isolated geographic section of Puget Sound. Restoration at the Nooksack River Delta would provide 25 percent of Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project. Inclusion of North Fork Skagit River Delta would restore

floodplain and tidal connectivity in the estuary of the Skagit River, the largest and most productive river in Puget Sound.

Restoration of these three sites would support major portions of multiple recovery plans including, but not limited to the Puget Sound Chinook Salmon Recovery Plan of 2005, the Washington Comprehensive Wildlife Conservation Strategy of 2005, the Northern Pacific Coast Regional Shorebird Management Plan of 2000, and the Pacific Coast Joint Venture of 1996. Restoration would support the Summer Chum Salmon Conservation Initiative. Restoration of these sites would also benefit State of Washington Priority Habitats and Species categories of wintering waterfowl, bald eagle, and native amphibians.

5 COMPARISON OF ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

Under NEPA, preparation of an EIS is triggered if a Federal action has potential to "significantly affect the quality of the human environment." Significance is based on the context and intensity of each potential effect. Context refers to the affected environment in which a project is proposed. Intensity refers to the severity of the effect, which is examined in terms of the type, quality, and sensitivity of the resource involved; location and extent of the effect; duration of the effect (short- or long-term); and other considerations. Beneficial effects are identified and described. The intensity of adverse effects refers to the degree or magnitude of a potential adverse effect, which is described as negligible, moderate, or substantial. Context and intensity are considered together when determining whether an impact is significant under NEPA.

This chapter provides information on issues relevant to selecting an agency preferred alternative and an environmentally preferred alternative as is required by NEPA. The analysis investigates the potential for proposed activities to affect (either adversely or beneficially) the various issues of concern and provides a comparative assessment of each alternative's expected effect on the environment. The assessment of environmental effects is based on a comparison of conditions with and without implementation of the proposed plan and related alternatives differentiated between the three action alternatives and the No-Action Alternative. Effects can be short-term or long-term, and beneficial or adverse. For the alternatives analysis in this chapter, the spatial scale of analysis focuses on the locations of the 18 proposed sites to provide a comparison between the No-Action Alternative and the three action alternatives. The time scale for analysis is a 50-year period beginning in 2015 extending to 2065. For all of the short-term construction effects identified in this chapter, these effects would be repeated in the event that adaptive management measures are undertaken after the appropriate monitoring period. Finally, certain topics were screened out of detailed analysis during the NEPA scoping process as described in section 3.5, and are therefore not covered in this section.

Alternative 3 is the environmentally preferred alternative due to having the greatest benefits for ecosystem function; however, Alternative 4 is selected as the agency preferred alternative as part of the implementation master plan as indicated in section 4.10.

5.1 PHYSICAL ENVIRONMENT: NEARSHORE PROCESSES AND STRUCTURES

This section provides an analysis of how each alternative would affect a variety of significant physical resources associated with nearshore processes and structures. Effects of the No-Action Alternative would avoid impacts from construction, but would forego the opportunity for important ecosystem restoration benefits. The action alternatives may have short-term

construction impacts lasting an estimated six months to two years, yet would have long-term benefits to the physical attributes of the nearshore zone supporting ecosystem functions. For the two sites in Alternatives 2 and 3 (Telegraph Slough and Everett Marshland) that are near navigation channels, site features would be engineered so as to cause no significant impacts to operations and maintenance costs for navigation.

5.1.1 Nearshore Ecosystem Processes

As described in section 3.1, nearshore ecosystem processes influence marine and estuarine shorelines over diverse spatial and temporal scales and are responsible for the different complexes of landforms supporting a wide variety of flora and fauna described in section 3.2.

5.1.1.1 *Alternative 1 – No-Action Alternative*

Under the No-Action Alternative, ecosystem processes at the proposed sites would likely remain degraded and impaired. Given the level of impairment to nearshore processes at these locations, the associated habitats and biological resources would continue to decline or fail to recover and rebuild their populations, which would be a substantial negative effect to Puget Sound.

5.1.1.2 *Alternative 2 – 11 Sites*

Alternative 2 includes at least one site from each of the formulated strategies (see section 4.1.1.2). This alternative would restore 5,348 acres of tidal wetlands and would remove 75,162 feet of stressors from the nearshore zone. Restoration measures at these 11 sites include removal of at least 10 tidal barriers for more natural inundation and estuarine mixing, remove shoreline armoring in at least two sites for better sediment erosion and transport, excavate tidal channels in at least four sites to initiate natural channel development, and add plantings to riparian zones to initiate vegetation succession and shading to keep water temperatures cool. These stressor removal measures would restore the natural processes that support the habitat and organisms. Processes that would be restored include natural formation of tidal channels in estuaries, unrestricted flow of freshwater rivers and streams into estuaries, unrestricted movement and migration of fish and wildlife, movement of sand and gravel along a shoreline, natural erosion and accretion of a beach, and natural exposure of a bluff to wind and wave action.

5.1.1.3 *Alternative 3 – 18 Sites*

Alternative 3 includes 18 sites that together address all four of the formulated strategies for process-based restoration. This alternative would restore 5,517 acres of tidal wetlands and would remove stressors from 113,094 feet of the nearshore zone. Restoration measures at these 18 sites would include removal of at least 15 tidal barriers, remove shoreline armoring in at least 4 sites, excavate or improve tidal channels in at least 7 sites, and would involve a much greater area of additional riparian plantings than would occur in Alternatives 2 and 4. These measures would restore a larger area of the ecosystem processes than Alternatives 2 and 4, and this alternative

adds a second beach restoration site, which is a rare restoration opportunity around the Puget Sound nearshore zone due to the length of shoreline in private ownership.

5.1.1.4 *Alternative 4 – 3 Sites*

Alternative 4 includes three sites; these are Duckabush River Estuary with 38 acres of saltwater and brackish wetlands restored, Nooksack River Delta with 1,807 acres of brackish and freshwater tidal wetlands restored, and North Fork Skagit River Delta with 256 acres of saltwater and brackish wetlands restored. This alternative would remove 1,270 feet of tidal barrier from the Duckabush Delta, and the Nooksack Delta site will have 11,910 feet of armor and tidal barriers removed. The North Fork Skagit site will remove 15,680 feet of shoreline armoring and will set levees well back from the river allowing a greater meander zone and tidal inundation. These amount to 2,101 acres of tidal wetlands restored and 28,860 linear feet of stressors removed from the nearshore zone allowing nearshore processes to return to the sites to support habitat and biological resources by influencing the physical structures of these sites. No beach restoration sites are included in this alternative.

5.1.2 Geologic and Physiographic Setting

The significant resources analyzed here are based on Shipman's (2008) classification system of geomorphological features that characterize the natural shoreline of Puget Sound. These landforms reflect the primary role of geomorphic processes in shaping the landscape. Approximately 10% of all Puget Sound shoreline is classified as "artificial" (Simenstad et al. 2011). Human-made structures and armoring inhibit the natural processes and are targeted for removal under the three action alternatives. The action alternatives represent substantial benefits.

5.1.2.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would continue the negative trajectory of the geologic and physiographic setting. The existing conditions would remain with artificial landforms that fail to support important habitats for Puget Sound species. One of the problems this study identified is the substantially decreased length and complexity of the Puget Sound shoreline. The combined shoreline length at all 18 proposed sites is 199,086 feet, or 38 miles as it has been shortened since historical conditions. Under the No-Action Alternative, this shoreline length would remain the same without improvement. Environmental protections and regulatory requirements may limit repair and/or replacement of artificial landforms, which may deteriorate over decades of exposure to natural elements (e.g. wind, waves). Natural landforms may re-emerge, but it would take decades for transition and there is high likelihood that human-made debris would be left behind to influence the natural landforms.

5.1.2.2 *Alternative 2 – 11 Sites*

Alternative 2 would remove artificial shoreline features and return sites to a more natural physiography that can support natural processes, by removing 75,162 feet of stressors from the

nearshore zone. This work would increase shoreline length by 131,578 feet over the existing length of the 11 sites. The resulting length would be 166% of the existing length. The landforms of this alternative that would change from artificial back to their historical form include one bluff-backed beach, six deltas in tidal freshwater zones, one delta in an estuarine mixing zone, one open coastal inlet, one barrier estuary, and one barrier lagoon with estuarine mixing. The beneficial effects would extend beyond merely the length of stressor removal, but would not be as substantial as the extent of Alternative 3.

5.1.2.3 *Alternative 3 – 18 Sites*

Alternative 3 would remove 113,094 feet of stressors from the nearshore zone. This work would increase shoreline length by 125,474 feet over the existing length of the 18 sites. The resulting length would be 147% of the existing length. The landforms of this alternative that would change from artificial back to their historical form include one bluff-backed beach and a barrier beach, six deltas in tidal freshwater zones, two deltas in estuarine mixing zones, four open coastal inlets, three barrier estuaries, and one barrier lagoon with estuarine mixing.

5.1.2.4 *Alternative 4 – 3 Sites*

Alternative 4 would remove 28,860 feet of stressors among the three sites. This work would increase shoreline length by 23,568 feet over the existing length of the 3 sites. The resulting length would be 132% of the existing length. The landforms of this alternative that would change from artificial back to their historical form include one delta in freshwater tidal zone (Nooksack), and two deltas in estuarine mixing zones (Duckabush and North Fork). The geographic range is primarily in northern Puget Sound and includes the Duckabush intertidal site in Hood Canal. Removal of stressors at these three sites would more than double the shoreline length at each site as well as collectively. This would restore sediment import and export processes at these sites.

5.1.3 Oceanography

Tides, currents, and waves are the characteristics of the vast volume of water contained within Puget Sound. The dynamic interactions between the water and land are forces of nature beyond the control of humans on a large scale; however, removing the artificial landforms from the nearshore zone can restore natural processes at a local scale. Removal of stressors at nearshore zone sites in most cases will have the following effects:

- Expand the tidal prism (tidal flow in and out of an area).
- Likely reduce the magnitude of tidal currents when barrier are removed.
- Result in diurnal changes in salinity and temperature in the estuary.
- Restore natural sedimentation processes.

5.1.3.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would leave in place all dikes, berms, and other stressors commonly associated with river deltas and waterfront development. This would continue to impede

freshwater input and estuarine mixing with negative effects on species that use the mixing zones for foraging, refuge, and reproduction, especially salmonids that use estuaries as critical transition zones between freshwater and saltwater life stages. At many of the proposed sites, freshwater input is channelized and confined to specific outlet locations, which creates localized areas of freshwater input and prevents natural mixing. Moderate habitat degradation would continue a downward trend through the period of analysis without restoration actions. The No-Action Alternative would have no effect on tides, currents, or wave action and would not meet the need to restore tidal wetlands and beach sedimentation.

5.1.3.2 *Alternative 2 – 11 Sites*

At eight of the 11 sites, degraded conditions would be rectified for freshwater input and distributary channel migration. This alternative would have no significant adverse effect on tides, currents, or interaction with the Pacific Ocean; in fact, it would restore 5,354 acres of tidal wetlands and beach area. This alternative would restore natural interaction between tidal and wave action with a bluff-backed beach (Beaconsfield Beach) and would allow natural sediment transport. This alternative includes one open coastal inlet (Deer Harbor Estuary) where the tidal barrier would be removed allowing tides, currents, and waves to interact with this landform. One barrier estuary (Dugualla Bay) and a barrier lagoon (Livingston Bay) would have their tidal barriers removed. These four sites amount to 833 acres of restored natural processes involving tides, currents, and waves. Other sites in this alternative are more related to freshwater reaches of the deltas, which would see benefits from increased tidal influence in their freshwater wetlands.

5.1.3.3 *Alternative 3 – 18 Sites*

At 15 of the 18 sites, degraded conditions would be rectified for freshwater input and distributary channel migration, which includes the largest river delta restoration opportunity in Puget Sound (Nooksack), along with several other large-scale sites. This alternative would have no significant adverse effect on tides, currents, or interaction with the Pacific Ocean; in fact, it would restore 5,523 acres of tidal wetlands and beach area. This alternative would restore natural interaction between tidal and wave action with a bluff-backed beach (Beaconsfield Beach) and a barrier beach (WDNR Budd Inlet Beach) and would allow natural sediment transport. There are four open coastal inlets where tidal barriers would be removed allowing tides, currents, and waves to interact with the landform at these locations. Three barrier estuaries and a barrier lagoon (Livingston Bay) would have their tidal barriers removed. These 10 sites amount to 965 acres of restored natural processes involving tides, currents, and waves. Other sites in this alternative are more related to freshwater reaches of the deltas, which would experience benefits from increased tidal influence in their freshwater wetlands.

5.1.3.4 *Alternative 4 – 3 Sites*

At all three of the sites in this alternative, degraded conditions would be rectified for freshwater input and the channel migration zone. Distributary channel migration would be improved at

Duckabush River Estuary and at the North Fork Skagit River Delta site. This alternative retains the largest proposed river delta restoration site (Nooksack); however, no beach restoration sites are included. One of these three sites amounts to 38 acres of restored natural processes involving tides, currents, and waves (Duckabush Estuary). The other two sites in this alternative are more related to freshwater reaches of the deltas, which would experience benefits from increased tidal influence in their freshwater wetlands.

5.1.4 Sedimentation and Erosion

Sediments move in longshore and cross-shore directions under the influence of wave and tidal forces. Artificial landforms in the nearshore zone hinder these natural processes that deliver substrates from areas of erosion to areas of deposition. Removal of stressors from the nearshore zone restores the natural processes that shape and influence the wetland and aquatic habitats critical for supporting VECs and ecosystem functions. Because substrate type determines species assemblages, nearly every type of flora and fauna of the nearshore zone would benefit from restoration of the natural sedimentation and erosion processes. Furthermore, restoration of these sediment transport processes would build resiliency into the ecosystem.

5.1.4.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would continue the degraded conditions of sedimentation and erosion processes, which would remain impaired at the proposed sites. Shoreline armoring would continue to prevent erosion of bluffs and transport of sediment to natural depositional features of beaches, bars, and spits. Other nearshore stressors would continue to disrupt longshore and cross-shore movement and sorting of substrates that support VECs such as forage fish.

5.1.4.2 *Alternative 2 – 11 Sites*

Alternative 2 would remove stressors from 75,162 feet of shoreline. Alternative 2 would restore sediment transport at 11 shoreline drift cells or deltas. Erosion of bluffs and restoration of tidal hydrology would allow for sediment transport and delivery that would provide appropriate substrate for wetlands, beaches, and submerged aquatic vegetation. Tidal and distributary channels would form at the mouth of these estuaries from the restored interactions between tidal hydrology and freshwater input. This alternative would meet the project purpose of nearshore process restoration but to a lesser degree than Alternative 3.

5.1.4.3 *Alternative 3 – 18 Sites*

Alternative 3 would remove stressors from 113,094 feet of shoreline. This would restore sediment transport, delivery, and erosion in each of these 18 shoreline drift cells or deltas. Benefits would be similar to those described for Alternative 2, but more so due to a greater amount of stressors removed. This would assist with rebuilding broad areas of wetlands by restoring appropriate substrate for their development and represents substantial positive effects.

5.1.4.4 *Alternative 4 – 3 Sites*

Alternative 4 would remove stressors from 28,860 feet of shoreline. This would restore sediment transport at these three delta sites. Restoration of tidal hydrology would allow for sediment transport and delivery that would provide appropriate substrate for wetlands, tidal distributary channels, and potentially for submerged aquatic vegetation at the Duckabush site. Tidal and distributary channels would form at the mouth of these estuaries from the restored interactions between tidal hydrology and freshwater input. This alternative would meet the project purpose of nearshore process restoration but to a lesser degree than Alternatives 2 and 3.

5.1.5 Hazardous, Toxic, and Radiological Waste (HTRW)

An HTRW site is defined as a site where a known or suspected uncontrolled release of a hazardous substance occurred, as defined in CERCLA (see section 3.1.5). Literature suggests that historically developed areas such as Puget Sound contain higher background concentrations of some hazardous substances that may affect biota, but these elevated background concentrations do not constitute HTRW as per ER 1165-2-132.

5.1.5.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would result in no change to the current status or future trends of HTRW contamination in Puget Sound.

5.1.5.2 *Alternative 2 – 11 Sites*

Based on available information, no HTRW sites exist in any of the 11 sites of Alternative 2. The WDOE has several databases that describe facilities of interest. The most general search is on their Facility/Site web page, which lists numerous facilities and sites of environmental interest (all 11 sites are represented in this search). A second database is their Confirmed and Suspected Contaminants Site List, which lists sites that are undergoing cleanup or awaiting further investigation (Everett Marshland, Dugualla Bay, and the Nooksack site have facilities on this list that are adjacent to, but not within, the proposed footprint). Lastly is the Hazardous Site List, which lists sites that have been assessed (Everett Marshland and Dugualla Bay have facilities on this list that are adjacent to, but not within, the proposed footprint).

Four of the 11 sites had historical industrial or commercial usage. Due to these uses, additional document research would be completed during PED to determine whether an uncontrolled release of hazardous substances occurred. Per ER 1165-2-132 *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, HTRW would be avoided entirely or the non-Federal sponsor would complete cleanup activities as a non-cost-shared action.

5.1.5.3 *Alternative 3 – 18 Sites*

Based on available information including current footprint, no HTRW sites exist in 16 of the 18 sites of Alternative 3. Among the three databases that WDOE maintains regarding facilities of interest, the following two sites are included. At the Point Whitney Lagoon site, a septic tank has been removed and the site is under voluntary cleanup. Based on the information contained in the Environmental Site Assessment Level I report, one uncontrolled release from a leaking underground storage tank was documented at the Budd Inlet Beach site. This tank has been removed and the site is under voluntary cleanup.

Ten of the 18 sites had historical industrial or commercial usage. Due to these uses, additional document research would be completed during PED to determine whether an uncontrolled release of hazardous substances occurred. Per ER 1165-2-132 *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, HTRW will be avoided entirely or the non-Federal sponsor will complete cleanup activities as a non-cost-shared action.

5.1.5.4 *Alternative 4 – 3 Sites*

A Phase 1 Environmental Site Assessment was completed for all sites under initial consideration. The Corps reviewed and updated these assessments for each of the three sites under current consideration (See Appendix B – Engineering). These most recent assessments were conducted in accordance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments*, and ER 1165-2-132: *HTRW Guidance for Civil Works Projects*. The updated Phase 1 assessments for the North Fork Skagit and Duckabush Estuary revealed no confirmed or suspected HTRW in the project footprints. At North Fork Skagit, the surrounding area has one site of concern; however, given the nature of the site and its contaminants, as well as its distance and hydraulic disconnection from the proposed project site, this site will not pose a significant or critical risk to Alternative 4. The Duckabush River Estuary portion of Alternative 4 has no known or suspected HTRW in the surrounding areas.

The Nooksack River portion of Alternative 4 has no known or suspected HTRW within its proposed footprint. The Phase 1 Environmental Site Assessment revealed several recognized environmental conditions in connection with areas adjacent to the project footprint, although all but one of these sites have no potential to impact the proposed project. The one exception is the Wilder Hazardous Waste Landfill site, located approximately a half mile east of the project footprint. Currently, there is no reason to believe that contaminants from this site are flowing into Claypit Pond (a small, artificial lake next to the landfill site) due to low permeability of the surrounding soils. However, inundation of Claypit Pond from the Corps project has a limited probability of changing the groundwater gradient, or more generally the overall hydrology, such that contaminants originating from the hazardous waste landfill could more easily flow into the pond. Therefore, the Corps project as well as potential users of the restored areas, have the potential to be impacted by contamination. Currently, the extent of this risk is unknown, and additional investigations will be conducted during PED. This risk and risk management strategy

is summarized in section 6.1.2. If the risk is found to be unacceptable, the non-Federal sponsor must decide how to manage that risk before construction occurs. Please refer to Appendix B for the complete assessment.

5.1.6 Water Quality

The primary contributor to diminished water quality at the proposed sites is polluted storm water runoff and excess nutrients from agriculture from the adjacent watersheds. The focus of the proposed work is stressor removal, which would not eliminate pollution sources to storm water; however, the proposed actions would increase the area of wetlands, which serve as natural filtration of pollutants in the environment. Construction activities for restoration projects often have short-term increases to turbidity that are minimized through specific construction practices.

5.1.6.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no effect on the status of the water quality parameters of the nearshore zone at the proposed sites. This alternative would fail to provide the important water filtration afforded by increased wetlands, which is critical to maintaining uncontaminated shellfish beds.

5.1.6.2 *Alternative 2 – 11 Sites*

Alternative 2 would restore 5,348 acres of tidal freshwater or estuarine mixing wetlands. Restoration would involve revegetation of riparian areas, which would increase shading and reduce water temperatures. Cooler water allows for higher concentration of dissolved oxygen, which benefits aquatic species. The increased area of wetlands would support a variety of functions that improve water quality, including sequestration of nitrogen and phosphates as well as pesticides and other chemicals that can harm the aquatic ecosystem. Temporary construction impacts may cause pulses of turbidity, but the duration of effect would only be a matter of hours; the overall benefits of Alternative 2 for water quality far outweigh minor construction effects. Improved water quality is critical to restoration of Puget Sound.

5.1.6.3 *Alternative 3 – 18 Sites*

Alternative 3 would restore 5,517 acres of tidal freshwater or estuarine mixing wetlands. At 15 of the 18 sites, restoration would involve revegetation of riparian areas, providing cooler water temperatures. The increased area of wetlands would support a variety of functions that improve water quality, including sequestration of nitrogen and phosphates as well as pesticides and other chemicals that can harm the aquatic ecosystem. Construction effects would be similar to those for Alternative 2, but would occur at more locations due to the larger number of sites. Likewise, the benefits of Alternative 3 would be similar to Alternative 2 but would cover a greater extent.

5.1.6.4 *Alternative 4 – 3 Sites*

Alternative 4 would restore 2,101 acres of tidal freshwater (Nooksack site) or estuarine mixing wetlands (Duckabush and North Fork sites). Restoration would involve revegetation of riparian areas at Nooksack and North Fork sites, which would increase shading and reduce water temperatures. Cooler water allows for higher concentration of dissolved oxygen, which benefits aquatic species. The increased area of wetlands at all three sites would support a variety of functions that improve water quality, including sequestration of nitrogen and phosphates as well as pesticides and other chemicals that can harm the aquatic ecosystem. Temporary construction impacts may cause pulses of turbidity, but the duration of effect would only be a matter of hours; the overall benefits of Alternative 4 for water quality far outweigh minor construction effects. The Corps would consult with WDOE during PED phase regarding minimizing construction impacts to water quality. Restoring wetlands would have a substantial benefit for water quality at these three sites, although the acreage of restoration is less than 40% of Alternatives 2 and 3.

5.1.7 Greenhouse Gas Emissions (GHGs)

Estimating the total quantity of GHGs that would be produced or absorbed by each of the proposed sites would require extensive analysis and numerous assumptions about each site's final design and construction. An estimation of GHGs should not only consider causes of GHG production, but also causes of GHG absorption, which offset and reduce the overall impact of GHGs. Artificial and natural reservoirs, or "sinks," absorb GHGs from the atmosphere. Large-scale natural carbon sinks include oceans, wetlands, grasslands, and forests. Vegetated land of any size, however, removes carbon from the atmosphere when the plants absorb CO_2 for photosynthesis. Most of the proposed actions involve active revegetation through landscaping and hydro-seeding or passive revegetation through removal of human-made structures (such as roads), which allows natural plant recruitment. All of these changes would increase absorption of CO_2, but the rate at which it is absorbed will depend on many factors, such as the type of plants, vegetation density, and climate. Therefore, it would be quite challenging to estimate GHG absorption for each site. Bearing the "rule of reason" in mind for structuring the GHG evaluation for an EIS, although an extensive quantified analysis cannot be done, a qualitative comparison can be drawn from simplified analysis of the primary causes of GHG production and absorption. The major sources of GHG emissions would be construction activities and construction materials, while the primary cause of carbon absorption would be increased vegetation. This section discusses these factors and how they can be used to estimate relative GHG emissions among the three alternatives and among the actions included in each alternative.

5.1.7.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no effect on GHGs. Alternative 1 does not involve construction activities and materials, and it would not change the amount of vegetation in the project area, so it would neither produce nor absorb GHG emissions.

5.1.7.2 *Alternative 2 – 11 Sites*

Simplified analysis of the construction activities and materials associated with the proposed actions for Alternative 2 indicates that this alternative would produce GHG emissions. At the same time, it would result in GHG absorption by increasing the vegetated land area. This analysis does not reveal whether the net effect would be an increase or decrease in global GHG quantities, although it does provide insight into the design and construction factors that affect GHG production and, more importantly, those factors that represent opportunities to mitigate the production of GHG, as introduced at the end of this section and detailed in section 5.7.3.

During construction activities, energy would be required to, for example, excavate soil, pave roadways, and haul materials to and from the site. The energy required for these activities would come from a hydrocarbon fuel (typically diesel) used by dump trucks, graders, pavers, and other construction equipment. The primary GHG produced during diesel combustion is CO_2. Therefore, the quantity of GHG emissions related to construction activities for the alternative can be estimated based on the quantity of diesel to be used during the construction at each site, as shown in Table 5-1 for Alternative 2 and Table 5-3 for Alternative 3.

Table 5-1. Estimated GHG Emissions Related to Construction Activities for Alternative 2

Site	Estimated Diesel Usage (gal)[1]	Estimated CO_2 Emissions (ton)[2]
Beaconsfield Feeder Bluff	5,200	58
Deepwater Slough	32,900	365
Deer Harbor Estuary	16,100	179
Dugualla Bay	336,100	3,731
Everett Marshland	2,249,200	24,966
Livingston Bay	61,200	679
Milltown Island	2,800	31
Nooksack River Delta	2,307,900	25,618
North Fork Skagit River Delta	539,800	5,992
Spencer Island	127,800	1,419
Telegraph Slough	992,300	11,015
Alternative 2 Total	6,671,300	74,053

[1] Quantity estimates were developed during preliminary cost analysis for the proposed sites.
[2] CO_2 emissions from diesel = 22.2 pounds/gallon (EPA 2005)

In addition to construction activities, construction materials represent a substantial source of GHG emissions for these actions. All materials have associated embodied emissions, or the emissions created throughout their lifecycles. For each product, the total embodied emissions depend on how the base materials are extracted, processed, transported, and constructed to create the final product, as well as how the product is disposed at the end of its usable life. Quantifying the total embodied emissions for all of the materials used on the proposed actions would require extensive analysis; however, it is reasonable to assume that the quantity of concrete and asphalt pavement used on these sites will provide a basis for comparison of the total embodied emissions

for the proposed actions. These quantities can be estimated based on the area (in square feet [SF]) of new roadway and new bridges to be constructed, as shown in Table 5-2 and Table 5-4.

Table 5-2. Estimated Major Construction Areas for Alternative 2

Site	Estimated New Roadway Area (SF)[1]	Estimated New Bridge Deck Area (SF)[2]
Beaconsfield Feeder Bluff	0	0
Deepwater Slough	0	0
Deer Harbor Estuary	6,100	3,500
Dugualla Bay	206,400	27,000
Everett Marshland	391,700	48,100
Livingston Bay	0	0
Milltown Island	0	0
Nooksack River Delta	902,300	118,800
North Fork Skagit River Delta	0	0
Spencer Island	0	0
Telegraph Slough	486,500	40,800
Alternative 2 Total	1,993,000	238,200

[1]New roadways may be constructed with asphalt pavement or concrete.
[2]Bridge deck area is used to convey relative quantities of concrete used to construct bridges; it does not account for all bridge elements, such as foundations and approach slabs.

Moreover, analysis of the actions that produce relatively high levels of CO_2 can provide insight into which construction activities would have the greatest impact on GHG emissions. The total GHG emissions for these actions would depend heavily on the quantity of materials that must be hauled and the distance they must travel. The estimates in Table 5-3 were based on approximate material quantities and assumed locations for material sources and disposal sites, but these factors may provide substantial opportunities for reducing GHG emissions as the actions approach final design and construction.

5.1.7.3 *Alternative 3 – 18 Sites*

Similar to Alternative 2, simplified analysis of Alternative 3 indicates that this alternative would result in both GHG production and GHG absorption. Table 5-3 shows the total estimated diesel usage and the associated CO_2 emissions.

Table 5-3 Estimated GHG Emissions Related to Construction Activities for Alternative 3

Site	Estimated Diesel Usage (gal)[1]	Estimated CO_2 Emissions (ton)[2]
Beaconsfield Feeder Bluff	5,200	58
Big Beef Creek Estuary	144,900	1,608
Deepwater Slough	32,900	365
Deer Harbor Estuary	16,100	179
Duckabush River Estuary	159,400	1,769
Dugualla Bay	336,100	3,731
Everett Marshland	2,249,200	24,966

Harper Estuary	57,200	635
Livingston Bay	61,200	679
Milltown Island	2,800	31
Nooksack River Delta	2,307,900	25,618
North Fork Skagit River Delta	539,800	5,992
Point Whitney Lagoon	54,200	602
Snow Creek and Salmon Creek Estuary	189,800	2,107
Spencer Island	127,800	1,419
Tahuya River Estuary	111,100	1,233
Telegraph Slough	992,300	11,015
WDNR Budd Inlet Beach	24,200	269
Alternative 3 Total	7,412,100	82,276

[1] Quantity estimates were developed during preliminary cost analysis for the proposed sites.
[2] CO_2 emissions from diesel = 22.2 pounds/gallon (EPA 2005)

These estimates do provide a reasonable basis of comparison among the actions even though they do not account for all construction activities. The estimates in Table 5-3 were based on approximate material quantities and assumed locations for material sources and dump sites, but these factors may provide substantial opportunities for reducing GHG emissions as the actions approach final design and construction. Because the proposed sites for Alternative 2 are a subset of those included in Alternative 3, the construction activities and materials associated with Alternative 2 would produce less GHG emissions than Alternative 3. This is confirmed by the estimated CO_2 emissions related to construction activities listed in Table 5-1 and estimated roadway and bridge deck areas listed in Table 5-2. It can be qualitatively concluded that Alternative 3 would increase GHG absorption because it would increase the area of vegetated land; as a result, a decrease in GHGs would be anticipated and an indirect beneficial effect to climate change from the absorbed GHGs.

Table 5-4. Estimated Major Construction Areas for Alternative 3

Site	Estimated New Roadway Area (SF)[1]	Estimated New Bridge Deck Area (SF)[2]
Beaconsfield Feeder Bluff	0	0
Big Beef Creek Estuary	26,800	30,000
Deepwater Slough	0	0
Deer Harbor Estuary	6,100	3,500
Duckabush River Estuary	63,600	35,200
Dugualla Bay	206,400	27,000
Everett Marshland	391,700	48,100
Harper Estuary	0	0
Livingston Bay	0	0
Milltown Island	0	0
Nooksack River Delta	902,300	118,800
North Fork Skagit River Delta	0	0

Point Whitney Lagoon	0	0
Snow Creek and Salmon Creek Estuary	90,000	28,500
Spencer Island	0	0
Tahuya River Estuary	27,800	21,000
Telegraph Slough	486,500	40,800
WDNR Budd Inlet Beach	0	0
Alternative 3 Total	2,201,200	352,900

[1]New roadways may be constructed with asphalt pavement or concrete.
[2]Bridge deck area is used to convey relative quantities of concrete used to construct bridges; it does not account for all bridge elements, such as foundations and approach slabs.

5.1.7.4 *Alternative 4 – 3 Sites*

Similar to Alternatives 2 and 3, simplified analysis of Alternative 4 indicates that this alternative would result in both GHG production and GHG absorption. Table 5-5 shows the total estimated diesel usage and the associated CO_2 emissions.

Table 5-5. Estimated GHG Emissions Related to Construction Activities for Alternative 4

Site	Estimated Diesel Usage (gal)[1]	Estimated CO_2 Emissions (ton)[2]
Duckabush River Estuary	159,400	1,769
Nooksack River Delta	2,307,900	25,618
North Fork Skagit River Delta	539,800	5,992
Alternative 4 Total	3,007,100	33,379

[1] Quantity estimates were developed during preliminary cost analysis for the proposed sites.
[2] CO_2 emissions from diesel = 22.2 pounds/gallon (EPA 2005)

Alternative 4 would employ substantially less material for new roadways and bridge decks for overall lower GHG production than Alternatives 2 and 3. Table 5-6 shows the total estimated major construction areas for Alternative 4.

Table 5-6. Estimated Major Construction Areas for Alternative 4

Site	Estimated New Roadway Area (SF)[1]	Estimated New Bridge Deck Area (SF)[2]
Duckabush River Estuary	63,600	35,200
Nooksack River Delta	902,300	118,800
North Fork Skagit River Delta	0	0
Alternative 3 Total	965,900	154,000

[1]New roadways may be constructed with asphalt pavement or concrete.
[2]Bridge deck area is used to convey relative quantities of concrete used to construct bridges; it does not account for all bridge elements, such as foundations and approach slabs.

It is clear that Alternative 4 would have substantially less GHG production and absorption by having fewer sites than Alternatives 2 and 3. Construction represents a short-term release of GHGs while restoration of vegetated land areas would be expected to result in a long-term carbon sink although that level of analysis is not provided here. This analysis does not reveal

whether the net effect would increase or decrease global GHG quantities but it provides some insight into GHG mitigation opportunities for the proposed actions.

Effects of GHG Emissions and Mitigation Measures

The potential effects of GHG emissions are by nature global and cumulative because they mix throughout the Earth's atmosphere from a variety of sources. The primary sources come from a few different sectors; various industries, energy sources such as coal and natural gas, personal consumption of fossil fuels, and natural causes are responsible for their release. The CO_2 emissions associated with the three alternatives have a minuscule difference when compared to the gigatonnes emitted globally every year; however, when GHG emissions from construction of restoration sites are combined with the GHG emissions from all sources and sinks, there would be a contribution to the global GHG emissions that are affecting climate change. Based on the enormity of GHG contributions from other sources, it is reasonable to assume that none of the alternatives for this project is large enough to have a significant effect on the climate because it would represent an extremely small fraction of the total GHG emissions produced globally.

Although the action alternatives would not cause substantial cumulative impacts associated with global climate change and there are no formally adopted NEPA thresholds of significance for GHG emissions, there are a number of mitigation measures that could be taken to reduce GHG emissions associated with Alternatives 2, 3, and 4. These measures would largely encompass best management practices (BMPs) related to conservation of construction materials and fuel used for construction activities and transportation of materials, as well as sequestration of CO_2 in restored wetlands and eelgrass beds. Details are provided in section 5.7.3.

5.1.8 Underwater Noise

The characteristics of sound pressure waves and animal sensitivity are described in section 3.1.8 of this document. Intrusive noise levels can have behavioral and physiological effects on animals. Behavioral consequences are actions such as abandoning hunting, diving or increasing swimming speed to flee the area, interrupted communication between individuals or pods, attempts to shield the young, and even panic and stranding (Richardson et al. 1995). Physiological consequences range from minor to lethal and can include temporary and permanent hearing loss, weight loss if prey cannot be captured, stress-induced health decline, and the lethal effect of hemorrhaging of the brain or other organs. Consequences from masked sounds can include other effects such as inability to avoid predators, being separated from the pod, or missed opportunities for group hunting. Chronic noise pollution can affect not only individuals, but also whole populations.

For a determination on whether construction related noise would affect marine mammals, fish, and birds, one must consider the frequency, location, intensity, and duration of the sound source as well as the audiogram of the recipient species. If an audiogram is available for a species, then using that audiogram helps to analyze the effects of noise on important biological resources;

otherwise, the hearing frequency range may be the best available information. Effects analysis requires calculating the sound exposure level (SEL) that the animal receives (described in section 3.1.8). Table 5-7 displays data collected on hearing capabilities of potentially affected species in the Nearshore Study area.

Table 5-7. Hearing capabilities of aquatic species and sound threshold for continuous and pulsed noise that can cause behavioral disruption and injury

Species	Audible Frequencies	Level B harassment (continuous)	Level B harassment (pulsed)	Level A injury
Fish (general)[2]	50Hz – 2kHz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Herring[2]	70Hz – 200Hz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Salmonids[2,7]	10Hz – 600Hz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Rockfish[8]	50Hz – 2kHz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Pinnipeds[5]	500Hz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
California sea lions	1kHz – 28kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Harbor seals	1kHz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Steller sea lions	500Hz – 32kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Mysticete whales[4]	10Hz – 8kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Minke whale[4]	10Hz – 500Hz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Odontocete whales[4]	100Hz – 500kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Killer Whale (orca)[3]	500Hz – 105kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Diving birds[9] (developed for marbled murrelet)	Not available, presumed at 1kHz – 5kHz	150 dB_{RMS} (guideline)	183 dB_{RMS} (onset of injury)	202 dB_{RMS}

[1] square root of the mean of the squares of the values recorded over a given time interval [2]Blaxter and Hoss 1981; [3] Hall and Johnson 1971, Bain et al. 1993, Szymanski et al. 1999; [4] Gordon and Moscrop 1996; [5] Schusterman et al. 1972; [6] Bailey et al. 2010; [7] Knudsen et al. 1992; [8] Skalski et al. 1992; [9] SAIC 2011

For a determination on whether construction related noise would affect marine mammals, fish, and birds, one must consider the frequency, location, intensity, and duration of the sound source as well as the audiogram of the recipient species. If an audiogram is available for a species, then using that audiogram helps to analyze the effects of noise on important biological resources; otherwise, the hearing frequency range may be the best available information. Effects analysis requires calculating the sound exposure level (SEL) that the animal receives (described in section 3.1.8). Table 5-7 displays data collected on hearing capabilities of potentially affected species in the Nearshore Study area.

5.1.8.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would not have any effect on the underwater noise conditions in Puget Sound since it would avoid additional construction noise in the marine environment.

5.1.8.2 *Alternative 2 – 11 Sites*

This ecosystem restoration project would not constitute any long-term change to underwater noise in Puget Sound; however, construction of the proposed sites would have short-term

underwater noise outputs that must be analyzed for effects on significant biological resources. At the current stage of site design, duration of noise-inducing activities cannot be estimated accurately at this time. During the next design phase, the potential effects would be thoroughly analyzed and all appropriate mitigation measures would be incorporated into construction methods. The activities that have been identified as part of the necessary construction work for this ecosystem restoration project are briefly described below:

- Pile driving may involve an impact pile hammer to drive steel piles into the substrate for solid support of the structures. For analysis in this document, the loudest sound level was used to assess effects; however, as an alternative to driving piles, construction could use vibration or hydraulic insertion methods. Another alternative to pile driving is drilled or augured holes for cast-in-place piles or piers. These methods would provide a significant sound reduction from traditional pile driving methods and would be used wherever feasible without sacrificing necessary structural integrity.
- A cofferdam or other water-isolation device most likely would involve use of a vibratory hammer for driving sheet-piles into sediment to encapsulate an area in the water to contain turbidity or to exclude aquatic animals. The frequency range is similar to round pole pile driving, but the decibel level is slightly quieter.
- Dredging may involve either a clamshell dredge or a pipeline dredge. Clamshell dredges produce various sound levels as they work and the decibel level depends largely on the substrate type with hard rock being louder than sand and mud. Pipeline dredges produce a constant sound profile at relatively low frequencies.
- Bridge construction often involves various construction methods including use of tugboats, drilling, rock placement, and pile driving. Some of these activities may be concurrent, but the nature of sound is such that sound pressure levels are not additive; for example, two boats idling at 85dB each would produce an audible sound at 88dB rather than 170dB. The SEL, however, would be calculated to estimate whether the duration of noise below the peak pulse threshold is creating enough energy to constitute harm or harassment to animals.

Implementing Alternative 2 would have no long-term effects on the ambient underwater noise conditions in Puget Sound. Construction would cause significant short-term noise disturbances at each of the 11 sites that have some noise-generating activity as described above. Sound levels would temporarily increase during construction with different characteristics and durations depending on the activity. Table 5-8 provides the noise-making construction activities and their likely dB level, along with how many sites in each alternative would have each type of activity. Potential noise-generating events associated with construction of each site were identified, and sound levels are estimated based on various data sources. Additionally, the sound pressure levels for the construction activities have been compared to the data available on aquatic species' hearing and the regulated sound threshold under the ESA and Marine Mammal Protection Act (MMPA) as presented in Table 5-7. Restoration work would involve noise levels that would cause behavioral responses or cause injury to aquatic animals if the noise were not mitigated.

However, construction methods would make every effort to use sound attenuation devices to reduce the noise below the regulatory thresholds.

Each method of construction that produces underwater noise can be mitigated through physical means such as bubble curtains and sound dampening mats, or through conservation measures such as having a certified monitor watching for wildlife. While noise may be significant at the construction sites, as the sound wave travels away from the noise-producing activity, the sound should attenuate below levels that cause harm to aquatic species.

5.1.8.3 *Alternative 3 – 18 Sites*

Implementing Alternative 3 would have no long-term effects on the ambient underwater noise conditions in Puget Sound. Ten sites in Alternative 3 have activities that would produce significant short-term underwater noise as described above. The temporary effects of noise that would occur during the construction necessary for Alternative 3 may include behavioral responses of animals that would flee the area, or could reach the level of physical harm. However, construction methods and timing would make every effort to use sound attenuation devices to reduce the noise below the regulatory thresholds. Alternative 3 has twice as many sites as Alternative 2 with noise-generating activities.

Table 5-8. Noise-making construction features and associated decibel levels for each alternative compared to the reaction or regulatory threshold under the ESA or MMPA

Construction Feature	Dominant Frequency and peak dB_{RMS}[1]	Alternative 2	Alternative 3	Alternative 4	Exceeds regulatory threshold for 1 or more species
Bridge construction (in-water work)[4]					
Rock placement	No data available, but likely similar to clamshell dredging	5 sites	9 sites	2 sites	Yes; mitigation available
Tugboats/barges	100-500Hz, 170 dB_{RMS}				
Drilling	100-500Hz, 160 dB_{RMS}				
Pile driving[3]	30Hz - 8kHz, 192 dB_{RMS}	5 sites	10 sites	0 sites	Yes; mitigation available
Installation of cofferdam – likely vibratory sheet-pile driving[5]	25Hz - 4kHz, 182 dB_{RMS}	5 sites	10 sites	0 sites	Yes; mitigation available
Dredging[2]	Pipeline (continuous noise): 70Hz - 1000Hz, 110 dB_{RMS} Clamshell (continuous noise): 5Hz - 10kHz, 124 dB_{RMS}	1 site	2 sites	0 sites	No

[1] square root of the mean of the squares of the values recorded over a given time interval [2]Dickerson et al. 2001; Clarke et al. 2002; [3] Betke et al. 2004; [4] Richardson et al. 1995; [5] Illingworth & Rodkin, Inc. 2007

5.1.8.4 *Alternative 4 – 3 Sites*

Two of the three sites in Alternative 4, Nooksack and Duckabush, will have in-water work for bridge construction; however, neither of these sites will have pile driving other than a minimal amount of test holes. Both of these sites will have piles removed, but this noise is not as loud as driving piles. Bridge supports will be drilled and cast-in-place concrete piers to avoid causing noise impacts to aquatic species. The North Fork site has no activities that would cause noise impacts to aquatic fish and wildlife. Overall, this alternative poses negligible effects.

5.2 BIOLOGICAL ENVIRONMENT: NEARSHORE FUNCTIONS

This section provides an analysis of how each alternative would affect important nearshore biological resources. Effects of the different alternatives on the biological environment could be negative or positive. Three timeframes were considered when analyzing the effects of the action alternatives: construction, transition, and long-term trajectory. Construction effects are largely negative, but would be temporary, lasting six months to two years. Transition of the sites is expected to last a few months to a decade, depending on the conditions and targets of a particular restoration site. Long-term benefits are expected to last 50 years or more.

5.2.1 Vegetation

5.2.1.1 *Alternative 1 – No-Action Alternative*

This alternative would not meet the project purpose and need to restore ecosystem functions and structures that support vegetation. Kelp and eelgrass beds would continue to receive insufficient sediment delivery and transport that provides essential nutrients and riparian vegetation would continue to be sparse and/or dominated by non-native species due to presence of stressors that interrupt sediment dynamics and tidal hydrology.

Marine Submerged Vegetation

Under the No-Action Alternative, marine submerged vegetation at the sites would continue to be limited by diminished sediment delivery (leading to lack of suitable substrate), and lack of solar incidence caused by overwater structures and increased turbidity due to impervious surface and lack of native vegetation. In addition, a lost opportunity of eelgrass and kelp bed colonization would continue in intertidal and sub tidal areas at the proposed sites that have been filled.

Wetlands

The wetlands at the proposed sites would continue to be suppressed by tidal barriers and fill. Any freshwater wetlands that are present, either naturally or due to tidal barriers, would continue to be vulnerable to the spread of reed canary grass (an aggressive non-native species). Although more shoreline development in the Puget Sound region is inevitable, any additional loss of these wetlands would largely depend on the regulatory environment and enforcement of laws that protect such wetlands, like Sections 401 and 404 of the Clean Water Act. Wetland restoration

efforts at the sites could occur, but would likely be a "piecemeal" approach rather than the large-scale process-based approach proposed here.

Riparian Vegetation

Riparian vegetation at the sites would continue to be displaced by the presence of shoreline stressors including shoreline armoring, railroads, dikes, and berms. Riparian areas likely would remain undisturbed, but continue to be dominated by invasive species of lesser ecological value.

5.2.1.2 *Alternative 2 – 11 Sites*

This alternative would remove 75,162 feet of shoreline stressors and restore 5,348 acres of tidal wetlands, which would promote the ecosystem structures and functions provided by wetlands, kelp and eelgrass beds, and riparian vegetation.

Marine Submerged Vegetation

Eelgrass occurs in patchy distributions at or near six of the 11 sites, and kelp beds occur in a patchy distribution at one site in this alternative. Temporary construction impacts to eelgrass and kelp would include turbidity caused by excavation and pulses of sediment released from newly tidally inundated areas, leading to potential for decreased light for the duration of construction and perhaps for a year as the storm season moves sediment away followed by recovery during the growing season. Long-term benefits would occur as sediment and nutrient transport increase when stressors are removed along approximately 113,094 feet of shoreline including armoring and tidal barriers, allowing for more suitable substrate and increases in light and nutrients nourishing growth and expansion of the beds within or along the fringes of the sites. Benefits may take two to four years to appear, but would endure for decades.

Wetlands

Under this alternative, the removal of tidal barriers and fill would restore 5,517 acres of tidal wetlands (both tidal freshwater and estuarine mixing). Additional areas of freshwater wetlands (not tidally influenced) are located at nine of the 11 sites; at most of these, the design proposes to remove tidal barriers to restore the estuarine mixing zone. This would convert these freshwater marshes into brackish marsh, a rarer ecotype. Due to the past disturbances created by diking and the proximity to agricultural lands, reed canary grass has likely pervaded these non-tidal freshwater wetlands. The other areas that would be tidally inundated are mostly agricultural lands that are no longer in use. As water of higher salinity inundates the restoration sites, the freshwater marsh vegetation would die off, leading to temporary decreases in vegetative cover until salt tolerant species colonize the area. Based on information from other estuarine restoration projects in the Puget Sound area, such as the Nisqually River estuary, it is likely that high marsh vegetation would establish within the first five years and lower marsh vegetation would take decades before establishment. Restoring these tidally influenced marshes would create a distribution of wetland zones that more closely matches pre-disturbance conditions, providing rearing and foraging areas for a variety of estuarine-dependent species.

Riparian Vegetation

Most riparian vegetation that would be impacted by construction activities, either by direct or indirect removal (removal of stressors with vegetation growing on them) consists of non-native species. Native vegetation would be protected to the extent possible. Invasive species would be replaced with native plants. As these riparian species become established, they would form an overhanging canopy that provides thermal refuge and a source of organic input for aquatic systems, as well as habitat for birds and small mammals. It is anticipated that there would be a net increase in riparian vegetation associated with this alternative.

5.2.1.3 *Alternative 3 – 18 Sites*

This alternative meets the project purpose and need by restoring 5,517 acres of tidal wetlands and removing 113,094 feet of shoreline stressors. In general, the substantial long-term benefits are greater than those described for Alternatives 2 and 4; however, there are greater short-term construction impacts associated with Alternative 3, although negligible in total impact.

Marine Submerged Vegetation

Eelgrass beds occur at or near 12 of the 18 sites in patchy and continuous distributions, and kelp occurs at or near four of the 18 sites in patchy distributions. Construction impacts would be similar to those described for Alternative 2, but to a greater extent due to the greater number of beds and the larger scale of construction. Benefits would be of similar types to those described for Alternative 2, with greater total benefit achieved since longer stressor length would be removed, providing proportionately more sediment delivery and nutrient transport.

Wetlands

Construction impacts on wetlands would be similar to those described for Alternative 2, but to a greater extent due to more freshwater wetlands being inundated with saltwater. Benefits would be similar to those described for Alternative 2, but would occur across a greater area since there would be more of the tidal wetlands restored than under Alternative 2.

Riparian Vegetation

Ten of the 18 sites include removal of invasive species and/or revegetation of riparian areas with natives. Construction impacts to riparian vegetation would be similar to those described for Alternative 2, but to a greater extent because of the larger number of sites. Benefits to riparian vegetation would be similar to those described in Alternative 2 with a larger area of riparian plantings and greater number and extent of stressors removed at Alternative 3 sites.

5.2.1.4 *Alternative 4 – 3 Sites*

This alternative would remove 28,860 feet of shoreline stressors and restore 2,101 acres of tidal wetlands, which would promote the ecosystem structures and functions provided by wetlands, kelp and eelgrass beds, and riparian vegetation. In general, there are fewer construction impacts associated with Alternative 4, but not as extensive long-term benefits due to having fewer sites.

Marine Submerged Vegetation
Eelgrass and kelp beds occur at Duckabush site and downstream from the Nooksack site in patchy and some continuous distributions. Construction impacts would be similar to those described for Alternative 2, but to a lesser extent due to the smaller number of beds and the smaller scale of construction. Benefits would be of similar types to those described for Alternative 2, with less total benefit achieved since shorter stressor length would be removed.

Wetlands
Construction impacts on wetlands would be similar to those described for Alternative 2, but to a lesser extent due to less area of freshwater wetlands being inundated with saltwater. Benefits would be similar to those described for Alternative 2, but would occur across a smaller area since there would be less area of tidal wetlands restored for Alternative 4.

Riparian Vegetation
Two of the three sites include removal of invasive species and/or revegetation of riparian areas with native shrubs and trees. The negligible construction impacts to riparian vegetation would be similar to those described for Alternative 2, but to an even lesser extent due to having fewer sites. Benefits to riparian vegetation would be similar to those described in Alternative 2, but across a smaller area of riparian plantings and less extent of stressors removed for Alternative 4.

5.2.2 Shellfish and other Macroinvertebrates

5.2.2.1 *Alternative 1 – No-Action Alternative*

Under Alternative 1, invertebrate communities on the human-made structures at the proposed sites would continue to be dominated by opportunistic, tolerant species, such as tube worms, barnacles, mussels, snails, and ascidians. Native clams, oysters, and other bivalves would be limited by lack of habitat due to the diking and filling of embayments, sub-optimal substrate due to interruption of sediment flow by shoreline armoring, and siltation caused by urban and agricultural run-off.

5.2.2.2 *Alternative 2 – 11 Sites*

Construction impacts on invertebrate communities would come from increases in turbidity and physical disturbance during beach regrading at one of the sites, dredging at one of the sites, and the removal of stressors in intertidal areas at all 11 sites. Removal of bridge pilings, abutments, and shoreline armoring, and the installation of water-isolation devices would be necessary at nearly all of the sites. These actions would have the short-term impact of disrupting or destroying benthic and epibenthic invertebrates. Once the stressors are gone, invertebrate colonization would follow a pattern of succession, with near complete recovery in one to three years (Hueckel and Buckley 1987, Martin 2012 pers. comm.) The 5,523 acres of restored habitat (which includes aforementioned tidal wetlands as well as beaches that would be restored) would transition to communities that include amphipods, isopods, and oligochaete and sabellid worms, as well as

insect larvae in more freshwater areas. Invertebrate density and diversity would likely increase as the restored sites transition to native estuarine marsh vegetation. A variety of invertebrates in the higher salinity areas of embayments and beaches, including native clams, oysters, snails, and cancer crabs would benefit from increased sediment delivery (leading to more suitable substrate) and additional habitat provided by the removal of shoreline armor and tidal barriers. Upper intertidal and back-beach invertebrates, such as beach hoppers, would benefit from removal of shoreline armoring and planting of riparian vegetation. Restored areas adjacent to eelgrass beds may serve to increase the size and quality of these beds, thus increasing habitat for nudibranchs, shrimp, crabs, jellyfish, and anemones.

5.2.2.3 *Alternative 3 – 18 Sites*

Construction impacts on invertebrate communities of Alternative 3 would be similar to those described for Alternative 2, but to a greater extent due to the larger number and scale of sites and therefore more bottom disturbance. Likewise, benefits would be similar to those under Alternative 2, but more so with Alternative 3 because it restores more acreage of intertidal habitat for invertebrates to colonize.

5.2.2.4 *Alternative 4 – 3 Sites*

Construction impacts on invertebrate communities at the three sites of Alternative 4 would be similar to those described for Alternative 2, but to a lesser extent due to fewer sites and therefore less substrate disturbance. Likewise, benefits would be similar to those under Alternative 2, but less so with Alternative 4 because it restores less total acreage of intertidal habitat for invertebrates to colonize. The Nooksack River Delta site will be designed to minimize water quality impacts from directing water from the Nooksack River into the Lummi River because highly valuable shellfish beds are in the estuary downstream from the Lummi River. Similarly, short-term and long-term effects of sediment to shellfish habitat at the Duckabush estuary will be minimized through design.

5.2.3 Fish

5.2.3.1 *Alternative 1 – No-Action Alternative*

The severe lack of functioning beaches is inhibiting support for beach spawning forage fish. The present fish populations would continue to use beach habitat that is degraded due to shoreline armoring effects on sediment dynamics, which in turn affect beach profiles and marine vegetation that provide valuable nursery and foraging habitat, as well as estuaries that provide rearing, foraging, and refuge habitat where dikes and causeways severely limit tidal hydrology.

Demersal/Benthic Fish

Many demersal/benthic fish species would not be affected by the persistence of stressors along the shoreline at the project sites. Much of the rocky habitat occupied by reef dwelling fish, such as rockfish and lingcod, has not undergone significant change and is not present at any of the

sites. The exceptions are fishes that use estuaries and softer substrate, such as flounder and certain sculpin species, and rockfish species that use kelp and eelgrass beds as nurseries for juveniles. These species would continue to be displaced by shoreline stressors such as tidal barriers, fill, and shoreline armoring.

Forage Fish

Forage fish would continue to be negatively affected by suboptimal habitat at the project sites, particularly since their spawning habitats on beaches and submerged vegetation are altered by shoreline stressors that hamper processes such as sediment delivery and nutrient transport. Although other restoration actions that benefit forage fish are likely to occur, these would not likely be the large-scale process-based efforts as proposed in this feasibility study.

Anadromous Fish

Under the No-Action Alternative, anadromous fish would continue to be limited by a lack of suitable habitat caused by the loss or modification of the shoreline. Bulkheads and over-water structures would continue to decrease shallow water habitat for migration, and diking and filling of estuarine habitat would limit rearing and spawning. Although many programs in Puget Sound and its associated river basins benefit salmonids, these would not be the large-scale program that restores ecological processes as proposed in this feasibility study and there would be no opportunity for synergistic benefits provided by multiple restoration programs in the region. The No-Action Alternative would maintain the status quo of stagnant or declining acreage of salmon habitat and would fail to assist with the recovery of these populations.

5.2.3.2 *Alternative 2 – 11 Sites*

Under Alternative 2, fish communities would see some short-term negative but primarily long-term positive effects. Negative effects would come from construction activities causing 1) increases in turbidity from excavation of fill and dikes and dredging, and 2) noise and vibration associated with pile and/or sheet-pile driving, dredging, and large equipment operation for excavation and demolition. See section 5.1.8 for a more detailed analysis of how noise might affect fish species. Elevated levels of turbidity could cause physiological damage to gills, and elevated noise could cause a behavioral response to flee or delay migration. Working within designated periods when fish are less likely to be present and during low tides would minimize effects of noise and turbidity on fish. The positive effects of Alternative 2 would vary among fish categories and among sites; details are discussed below.

Demersal/Benthic Fish

Most reef-dwelling fish, such as rockfish and greenlings, would not be affected by the proposed actions since none of the actions occur where there is substantial reef habitat. Predatory fish like lingcod that are typical of reef habitats that feed heavily on forage fish (Beaudreau 2009) would benefit from increases in habitat for those forage fish species (discussed in the following section). Juvenile rockfish species that use kelp and eelgrass beds as nurseries would benefit

from improvement to these habitat types. Several of the sites are located in river deltas, embayments, and beaches where there is finer substrate. Fish that occupy this habitat, such as flounder and certain species of sculpin, would benefit from the removal of tidal barriers and armoring, thus expanding brackish areas (5,517 acres) for foraging.

Forage Fish

Forage fish species that use beaches and submerged aquatic vegetation for spawning, such as sand lance and herring, would benefit from restored sites where 115,718 feet of armoring, tidal barriers, and other nearshore structures that inhibit sediment delivery and nutrient transport would be removed. Forage fish that use river deltas, such as longfin smelt and eulachon, would benefit from restored sites where tidal barriers would be removed, leading to an increase in spawning and foraging habitat. These benefits to forage fish would also benefit species in higher trophic levels since the forage fish are a preferred prey item for a variety of nearshore species.

Anadromous Fish

Anadromous fish, particularly salmonids, would benefit from restored sites where armoring, tidal barriers, and fill in river deltas, embayments, and beaches would be removed. Removal of shoreline armoring would result in 1) more shallow water habitat used for juvenile migration (particularly Chinook and chum), 2) a potential increase in eelgrass beds that are used by juvenile salmonids (mostly Chinook and chum) as nurseries for holding and rearing, and 3) more suitable spawning beaches and kelp and eelgrass beds for forage fish that are preferred prey of salmon. Removal of tidal barriers would result in 5,517 acres of restored tidal wetlands for juvenile rearing and foraging. Other anadromous species, such as sturgeon and anadromous forage fish, would also benefit from this estuarine habitat.

5.2.3.3 *Alternative 3 – 18 Sites*

Negative effects from construction would be more disruptive to fish communities than under Alternative 2 due the greater number and scale of the sites under this alternative, which requires removal of more roads and levees, construction of more levees, more raising of roads, and more bridge building. A greater number of sites in Alternative 3 would require dredging, excavation of fill, and pile and/or sheet-pile driving, causing greater increases in turbidity, noise, and vibration than Alternative 2.

Beneficial effects to fish communities would be similar to those discussed for Alternative 2, although to a greater extent. This is due to 1) more tidal wetlands restored for rearing and foraging, 2) more spawning and foraging habitat for forage fish species (a preferred prey item of salmon) because of more shoreline stressor length removed, and 3) more benefit to kelp and eelgrass beds that provide juvenile rearing habitat.

5.2.3.4 *Alternative 4 – 3 Sites*

Negative effects from construction would be substantially less disruptive to fish communities than under Alternatives 2 and 3 due the smaller number and scale of the sites under this alternative, which requires removal of fewer roads and levees, construction of fewer levees, less raising of roads, and less bridge building. Fewer sites in Alternative 4 would require dredging, excavation of fill, and are not likely to include any pile and/or sheet-pile driving, causing fewer short-term increases in turbidity, noise, and vibration than Alternatives 2 and 3.

Beneficial effects to fish communities would be similar to those discussed for Alternative 2, although to a lesser extent. This is due to 1) less tidal wetlands restored for rearing and foraging, 2) less spawning and foraging habitat for forage fish species (a preferred prey item of salmon) because of less shoreline stressor length removed, and 3) less benefit to kelp and eelgrass beds that provide juvenile rearing habitat. Alternative 4 does not include any beach restoration sites, primarily due to a lack of willing landowners; therefore, there is no opportunity for benefits to the beach-spawning forage fish in this alternative.

5.2.4 Birds

5.2.4.1 *Alternative 1 – No-Action Alternative*

Birds at the project sites would continue to be limited by lack of suitable estuarine tidal flats and eelgrass beds that provide foraging habitat. Loss of habitat for bird prey, including forage fish, juvenile salmonids, a variety of invertebrates, and marine vegetation would affect species such as great blue herons, dunlins, sandpipers, and brandts. Opportunistic species like gulls, Canada geese, and crows would continue to flourish at the sites due to their adaptation to the human environment. Migratory species that use the agricultural fields in the winter are likely to continue to be populous, assuming there is no future urbanization in those areas.

5.2.4.2 *Alternative 2 – 11 Sites*

Construction activity including pile driving, demolishing roads and bridges, and hauling off large amounts of material would cause temporary disturbances to bird communities due to noise (both airborne and underwater) and the presence of heavy equipment. See section 5.1.8 for more details on how underwater noise may affect diving birds. These disturbances would likely cause a behavioral response to flee the area. Best management practices, such as working outside of the nesting season, would minimize these impacts. At several sites, agricultural areas would be flooded due to removal of tidal barriers. These areas are often used heavily by migratory species; allowing tidal flow to enter would likely lead to a transition from communities dominated by snow geese and trumpeter swans (which are not habitat limited in the Puget Sound region) to a wider variety of species like goldeneye, sandpipers, wigeons, scaups, and brandts that are associated with saltwater habitats. Freshwater marshes that would be flooded with brackish water would transition from species like mallards and pintails to the saltwater species mentioned previously. A variety of birds that depend on forage fish and juvenile and adult salmon would

greatly benefit from restored sites where these fishes' habitats (including marshes, eelgrass beds, and spawning beaches) are increased.

5.2.4.3 *Alternative 3 – 18 Sites*

Construction effects on bird communities would be similar to those described for Alternative 2, but to a greater extent due to the larger number and scale of the sites. Transitions to bird communities that are more indicative of saltwater in agricultural areas and freshwater areas are expected under this alternative as well; however, the benefits to shorebirds and waterfowl would be greater than Alternative 2 since there would be more acreage of tidal wetland creation or improvement for their use and to support their prey.

5.2.4.4 *Alternative 4 – 3 Sites*

Construction effects on bird communities would be similar to those described for Alternative 2, but to a lesser extent due to fewer sites. Transitions to bird communities that are more indicative of saltwater in agricultural areas and freshwater areas are expected at the North Fork site. Overall benefits to shorebirds and waterfowl would be the same types of habitats as Alternatives 2 and 3 but would have a lesser extent as there would be less acreage of tidal wetland creation or improvement for their use and to support their prey.

5.2.5 Marine Mammals

5.2.5.1 *Alternative 1 – No-Action Alternative*

Marine mammals dependent on prey that use the nearshore zone would continue to be limited by the lack of suitable habitat for those prey. This would particularly affect the Southern Resident killer whales, which feed preferentially on Chinook and chum salmon. Fill, dikes, and shoreline armoring at the project sites limit the area and quality of haul-out locations for harbor seals.

5.2.5.2 *Alternative 2 – 11 Sites*

The primary impacts to marine mammals would result from noise disturbances caused by pile and/or sheet-pile driving, which could cause behavioral response such as fleeing, interfere with ability to locate prey, or result in physiological damage. See section 5.1.8 for a more detailed analysis of how noise may affect marine mammals. All of the sites requiring pile driving are located in shallow embayments and river deltas, and this activity would predominantly occur during low tides to minimize underwater noise. Harbor seals are the marine mammal most likely to be affected by noise due to their ubiquitous distribution in Puget Sound and their tendency to swim into river deltas and embayments, where most of the sites are located. With the exception of Deer Harbor, Southern Resident killer whales are not likely to occur in the project areas during pile driving since it would occur during designated work periods when the killer whales are concentrated around the San Juan Islands and southern Vancouver (Hauser 2007, Kriete 2007). Transient killer whales are only intermittent visitors of Puget Sound so the likelihood is low that this pile driving would harm them. Other cetaceans, including baleen whales and

porpoises require deeper water than what occurs at the project sites, so they have a low likelihood of encountering pile driving, especially if it occurs during low tides. Elevated turbidity could cause temporary displacement of marine mammals as well, likely those that occur in shallower water, such as harbor seals.

Long-term benefits to marine mammals would be closely tied to the benefits provided to their prey, including increased habitat for forage fish and salmonids (discussed in previous sections). Southern Resident killer whales would likely gain the most benefits from restoring processes that increase habitat for Chinook and chum salmon. Other marine mammals like porpoises, sea lions, and seals would benefit as well, but to a lesser extent since their diet consists of a wider variety of fish, some of which are not nearshore dependent. For example, harbor seals feed preferentially on herring from December through March, but generally select hake for the remainder of the year (Olesiuk 1993), which is not a nearshore-dependent species. Other benefits include better beach habitat for harbor seal haul-out due to the removal of shoreline armoring, and increased foraging habitat due to the removal of tidal barriers.

5.2.5.3 *Alternative 3 – 18 Sites*

Negative effects to marine mammals would be similar to those discussed for Alternative 2, but to a greater extent because of the larger number and scale of sites that require pile driving, and the closer proximity to summertime Southern Resident killer whale distribution. Benefits to marine mammals that feed on nearshore-dependent species would be more than Alternative 2, as Alternative 3 restores substantially more tidal wetlands that support their prey and removes a great deal more shoreline stressors. This would mean more foraging area for pinnipeds, particularly harbor seals, under Alternative 3, which includes a second beach restoration site with its potential as a harbor seal haul-out site.

5.2.5.4 *Alternative 4 – 3 Sites*

Negative effects would be similar to Alternative 2, but to a much smaller extent due to the smaller number and scale of sites with construction in marine habitat. Only Duckabush would have noise or turbidity in an estuary adjacent to marine mammal habitat. Benefits to marine mammals that feed on nearshore-dependent species would be less than Alternatives 2 and 3, as those restore substantially more tidal wetlands that support marine mammal prey items. This would mean less benefit to foraging area for pinnipeds, particularly harbor seals, under Alternative 4, which does not include any beach restoration sites.

5.2.6 Invasive Species

5.2.6.1 *Alternative 1 – No-Action Alternative*

Under the No-Action Alternative, invasive species would continue to exploit human-made structures at the project sites and out-compete native species.

5.2.6.2 *Alternative 2 – 11 Sites*

The proposed sites have not been surveyed for invasive species. If invasive species are present, removal of human-made structures paired with revegetation efforts would lead to repopulation with native species that are more likely to colonize the estuarine and beach habitat.

5.2.6.3 *Alternative 3 – 18 Sites*

Effects of this alternative would be similar to those described for Alternative 2, but to a greater extent due to removal of substantially longer linear footage of human-made structures.

5.2.6.4 *Alternative 4 – 3 Sites*

Effects of this alternative would be similar to those described for Alternatives 2 and 3, but to a lesser extent due to removal of substantially less linear footage of human-made structures.

5.2.7 Rare, Threatened, and Endangered Species

Many of the species discussed in section 3.2.7 occur at the 18 sites analyzed in this document. Table 5-9 summarizes the federally threatened and endangered species associated with all 18 of the proposed project sites (USFWS 2012).

5.2.7.1 *Alternative 1 – No-Action Alternative*

ESA-listed species at the sites would continue to be limited by shoreline stressors that impede natural, habitat-forming processes. These inhibited processes have implications that ascend trophic levels. Chinook, Hood Canal chum, steelhead, and bull trout would continue to be limited by sub-optimal rearing and foraging habitat at the site locations, as well as lack of suitable habitat for prey species like forage fish. Southern Resident killer whales, which are dependent on these salmonids, would, by trophic association, also be limited by this lack of habitat. ESA-listed rockfish would not likely be affected, since they are typically associated with rocky substrate in deeper water and are more vulnerable to fishing pressure than shoreline stressors. However, the persistence of stressors that inhibit processes necessary for healthy kelp and eelgrass beds, which serve as nurseries, may continue to limit juvenile rockfish.

5.2.7.2 *Alternative 2 – 11 Sites*

Construction impacts on rare, threatened, and endangered species would be similar to those discussed for fish, mammals, and birds in previous sections. Primary impacts would be elevated turbidity from excavation, and noise and vibration associated with pile driving. Both of these impacts could cause a behavioral response of fleeing or delayed migration, and/or physiological damage. These impacts would be minimized by adhering to the conservation measures recommended by USFWS and NMFS, including working during designated periods when ESA-listed species are least likely to be present and during low tides.

Positive effects on ESA-listed species would be similar to those discussed for fish, birds, and mammals in previous sections. The removal of stressors along over 70 miles of shoreline at these 11 sites would increase habitat-forming processes for many ESA-listed species, leading to responses at many trophic levels. Removing tidal barriers, fill, and armoring would increase foraging and rearing habitat for juvenile salmonids (5,517 acres of tidal wetlands), as well as increase sediment delivery and nutrient transport to encourage spawning of forage fish (an important prey item for salmon) on beaches and kelp and eelgrass beds. Eulachon are present at two of the 11 sites and would see habitat benefits from restoration. Improvements in kelp and eelgrass beds would provide better nurseries for juvenile ESA-listed salmonids and rockfish. Removal of shoreline armoring would increase sediment delivery for forage fish spawning and create shallow water habitat for the migration of juvenile Chinook salmon. These improvements in habitat for forage fish and salmon would lead to an increase in prey base for marbled murrelet, humpback whales, and Southern Resident killer whales. This alternative has no sites in Hood Canal; therefore, ESA-listed summer chum here would not see benefits.

Table 5-9. Federally Listed Threatened and Endangered Species and Critical Habitat Occurring in or around the Project Sites

Project Site	Bocaccio	Canary Rockfish	Yelloweye Rockfish	Eulachon	Hood Canal Summer Chum		Puget Sound Chinook Salmon		Coastal/ Puget Sound Bull Trout		Puget Sound Steelhead	Green Sturgeon	Southern Resident Killer Whale		Humpback Whale	Marbled Murrelet	Golden Paint Brush
					Sp	CH	Sp	CH	Sp	CH			Sp	CH			
Beaconsfield Feeder Bluff	x	x	x				x	x	x	x	x		x		x	x	
Deepwater Slough							x	x	x	x	x						
Deer Harbor Estuary	x	x	x	x			x	x			x	x	x	x	x	x	
Dugualla Bay	x	x	x				x	x	x	x	x		x			x	
Everett Marshland							x	x	x	x	x						
Livingston Bay	x	x	x				x	x	x	x	x		x			x	
Milltown Island							x	x	x	x	x						
Nooksack River Delta				x			x	x	x	x	x	x	x	x	x	x	
North Fork Skagit River Delta							x	x	x	x	x		x[1]	x[1]			
Spencer Island							x	x	x	x	x						
Telegraph Slough	x	x	x				x	x	x	x	x						
Big Beef Creek Estuary	x	x	x		x	x	x	x	x		x		x		x	x	
Duckabush River Estuary				x	x	x	x	x	x	x	x		x		x	x	
Harper Estuary	x	x	x				x	x	x	x	x		x		x	x	
Point Whitney Lagoon	x	x	x	x	x	x	x	x	x	x	x		x		x	x	
Snow Creek and Salmon Creek Estuary	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Tahuya River Estuary	x	x	x		x	x	x	x	x	x	x		x		x	x	
WDNR Budd Inlet Beach	x	x	x				x	x	x		x		x			x	

Sp-species, CH-critical habitat. If CH is not listed underneath a given species then it is not present at any of the project sites.
Note 1: Only prey items of Southern Resident Killer Whale are present.

Other species that are rare but not ESA-listed include Coho salmon, northern abalone, sea otters, California buttercup, and sharpfruited peppergrass. While Coho salmon would certainly benefit from the increased rearing habitat, the other species are not likely to be affected since they tend to occupy rocky shorelines.

5.2.7.3 *Alternative 3 – 18 Sites*

Construction effects to ESA-listed species would be similar to those for Alternative 2, but to a greater extent due to the larger number and scale of the sites and their locations. Alternative 3 has more sites in Hood Canal and in northern Puget Sound, where there tends to be higher numbers of ESA-listed species because of the proximity to the Strait of Juan de Fuca and Strait of Georgia with their greater biodiversity. Since Hood Canal summer chum, eulachon, and green sturgeon are present at more sites in this alternative, they see more impacts from construction activities; conversely, they would gain more long-term benefits. Benefits to other species would be similar to those discussed for Alternative 2 but to a greater degree due to substantially more acreage of restored tidal wetlands and much longer length of shoreline stressors removed. Project sites in Hood Canal and southern Puget Sound where wetlands would be restored could improve water quality for Olympia oysters (a depleted species that were once common in Puget Sound), as results of this project combine synergistically with results of other recovery efforts.

5.2.7.4 *Alternative 4 – 3 Sites*

Construction impacts to ESA-listed species located in or near the three sites of this alternative would be similar to those discussed for Alternatives 2 and 3, such as elevated turbidity from excavation, and noise and vibration associated with pile driving; although, the only pile driving for this alternative is for testing and pile removal and would therefore be quieter. Impacts could cause a behavioral response of fleeing or delayed migration, and/or physiological damage. These impacts would be minimized by adhering to the conservation measures recommended by USFWS and NMFS, including working during designated periods when ESA-listed species are least likely to be present and during low tides. Table 5-10 provides a summary of the effects determinations at each of the three sites in Alternative 4. Details and rationale for these determinations were provided to NMFS and USFWS in Specific Project Information Forms as part of the Section 7 consultation process. In each case where a "Likely to Adversely Affect" determination has been made, this is due to short-term construction impacts, which will be outweighed by the long-term benefits of the project. The ESA consultation documents appear in Appendix J.

Positive effects on ESA-listed species would be similar to those of Alternatives 2 and 3, but to a lesser extent due to having only three sites in Alternative 4. This alternative removes over 5 miles of shoreline armoring that inhibits the natural processes that support habitat development for the ESA-listed species at these sites. Unlike Alternative 2, this alternative includes the Duckabush River Estuary site in Hood Canal, which would benefit Hood Canal summer chum.

Table 5-10. Summary of effects determinations for ESA-listed species and their critical habitat associated with the proposed restoration sites of Alternative 4.

	Duckabush Estuary	Nooksack River Delta	North Fork Skagit River Delta
Bocaccio	NE	NE	NE
Canary Rockfish	NE	NE	NE
Yelloweye Rockfish	NE	NE	NE
Eulachon	NE	NE	NE
Hood Canal Summer Chum	LAA	LAA	LAA
critical habitat	NLAA	NLAA	NLAA
Puget Sound Chinook Salmon	LAA	LAA	LAA
critical habitat	NLAA	NLAA	NLAA
Coastal/Puget Sound Bull Trout	LAA	LAA	LAA
critical habitat	NLAA	NLAA	NLAA
Puget Sound Steelhead	LAA	LAA	LAA
Green Sturgeon	NE	NE	NE
Southern Resident Killer Whale	NLAA	NLAA	NLAA
critical habitat	NLAA	NLAA	NLAA
Humpback Whale	NE	NE	NE
Marbled Murrelet	NLAA	NE	NE
Spotted Owl	NE	NE	NE
Golden Paintbrush	NE	NE	NE

NE = No Effect; NLAA = Not Likely to Adversely Affect; LAA = Likely to Adversely Affect

5.3 CULTURAL RESOURCES

Effects to cultural resources and historic properties are discussed in the context of the regulations implementing Section 106 of the National Historic Preservation Act (NHPA)(36 CFR 800). Section 106 requires Federal agencies to take into account the effects of their actions on historic properties. Historic properties are cultural resources that are eligible for listing or listed on the National Register. As described in section 3.3, cultural resources at a minimum must be 50 years old or older to be considered eligible for the National Register, although more recent properties with exceptional significance may be considered. Each of the 18 proposed sites was analyzed for its potential to affect cultural resources. The analysis is broken down broadly by the categories of places or properties for which specific information exists in the available records or has been provided through consultation: prehistoric and historic archaeological resources, and historic buildings and structures.

5.3.1 Archaeological Resources

The geographical areas identified in this study for nearshore restoration overlaps with those areas that were used by native populations for village locations, resource gathering areas, and other uses; therefore, there is a high probability of encountering cultural resources in any nearshore restoration sites, not just those identified in these three action alternatives.

5.3.1.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no immediate effect on prehistoric archaeological resources. Artificial and natural processes may continue to erode and deteriorate known archaeological resources, while exposing previously undiscovered sites and isolated artifacts. No change would occur in the management condition of archaeological resources; Federal actions or undertakings would continue to be reviewed in accordance with Section 106 of the NHPA. Even without implementing nearshore restoration described in the subsequent action alternatives, there will continue to be significant risks of loss of cultural resources resulting from development, natural processes, and recreation.

5.3.1.2 *Alternative 2 – 11 Sites*

This alternative has a significant potential to impact prehistoric archaeological resources, although not as great as Alternative 3 because there are fewer restoration sites. For the 11 restoration sites included in the TSP, cultural resource surveys have been conducted within portions of ten sites. The exception is the Beaconsfield Feeder Bluff site. Six of the restoration sites contain previously recorded archaeological sites. Of the 28 previously recorded archaeological sites within the TSP, only one is eligible for listing on the NRHP; the remaining 27 archaeological sites are unevaluated. Deer Harbor contains one lithic scatter site. Dugualla Bay contains six shell midden sites. Livingston Bay contains one shell midden site. The Nooksack River Delta restoration site contains 13 unevaluated archaeological sites ranging from shell middens, and lithic scatters and a historic debris scatter (Table 5-11). The North Fork Skagit River Delta contains five previously recorded archaeological sites, and one archaeological district is located either within or directly adjacent to the restoration site. These sites include a pre-contact habitation site that is a contributing element to Fishtown Archaeological District located adjacent to the restoration site with the remainder identified as shell middens (See Table 5-11). The Everett Marshland site contains one lithic scatter. The Spencer Island site contains a shell midden along the eastern border of the project area.

The locations of most of the proposed sites present a moderate to high potential for archaeological resources to exist, as Native American Tribes often constructed village locations at the confluences of streams and rivers. A comprehensive inventory and National Register evaluation of all prehistoric archaeological resources and traditional cultural properties at each site would need to be completed in PED; inventory work for each site should be conducted no more than five years in advance of construction. The Corps would consult with the SHPO and other interested parties regarding identification and evaluation strategies, and develop and implement mitigation measures prior to construction where adverse effects could not be avoided. During preparation of the Draft FR/EIS, the Corps initiated NHPA Section 106 consultation on Alternative 2 (the TSP). Since then, the recommended plan changed to Alternative 4 (see below). With the exception of the Nooksack River Delta and the North Fork Skagit River Delta (Alternative 2 sites in common with the recommended plan), any of the restoration sites that may

be carried forward from Alternative 2 under other authorities would undergo their own Section 106 consultation should they become authorized (see Alternative 4 below for the PA process).

5.3.1.3 *Alternative 3 – 18 Sites*

This alternative has a significant potential to impact prehistoric archaeological resources. This alternative contains seven additional restoration sites (Big Beef Creek Estuary, Duckabush River Estuary, Harper Estuary, Point Whitney Lagoon, Snow Creek and Salmon Creek Estuary, Tahuya River Estuary and WNDR Budd Inlet Beach) compared to Alternative 2. Of these seven additional sites, all but one (Point Whitney Lagoon) have had previous cultural resource surveys conducted within portions of the restoration sites. One archaeological site (remnants of a historic fence and fruit tree) has been recorded in the Duckabush River Estuary but has not been formally evaluated (See Table 5-11). A comprehensive inventory and National Register evaluation of all prehistoric archaeological resources and traditional cultural properties at each site would need to be completed; inventory work for each site should be conducted no more than five years in advance of construction. The Corps initiated consultation on the 18 sites, but has not fully consulted on any of the sites in this alternative other than the three in the preferred alternative. The Corps would consult with the SHPO and other interested parties regarding future identification and evaluation strategies, and develop and implement mitigation measures as identified in the PA prior to construction where adverse effects could not be avoided.

5.3.1.4 *Alternative 4 – 3 Sites*

As with the other two action alternatives, this alternative has significant potential to impact prehistoric and historic archaeological resources. All three sites have had previous cultural resource surveys conducted within portions of the restorations sites. In addition, all three locations contain previously recorded archaeological sites and have a high potential for containing additional unrecorded archaeological sites. The majority of the previously recorded archaeological sites have not been formally evaluated for the National Register. Table 5-11 lists the known archaeological sites that are located in each of the three proposed restoration sites of the Recommended Plan.

The Corps has prepared a Programmatic Agreement (PA) outlining the Section 106 process that will be followed (Appendix D). The PA includes which Section 106 tasks need to occur prior to construction (e.g. fieldwork), how Section 106 consultation will occur, how determinations of eligibility will be made, how findings of no adverse effect will be determined, how findings of adverse effects will be made, and how the PA will be implemented, and a dispute resolution procedure. In addition, the PA provides for a variety of treatment measures that can be used for mitigation of an adverse effect (See Appendix E of the PA). The treatment measures are standard types of mitigation actions used for adverse effects and the costs of these treatment measures have been taken into account during cost estimation for this project.

Table 5-11. Known archaeological sites located in the Nooksack River Delta, North Fork Skagit River Delta, and Duckabush Estuary proposed restoration sites.

Site Number*	Description	NRHP Eligibility	Location	Potential Effect to Resource Based on Current Design**
Nooksack River Delta Archaeological Sites				
45SH27	Pre-contact shell midden; Pre-Contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH170	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Unknown at this time
45WH526	Pre contact shell midden-possible village	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH723	Pre-contact shell midden; pre contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH734	Pre-contact lithic scatter	Uuevaluated	In project area	Appears that there will be no effect based on current project design
45WH742	Pre-contact isolate	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH847	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH848	Pre-contact shell midden	Unevaluated	Iu project area	Appears that there will be no effect based on current project design
45WH862	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH863	Pre-contact lithic scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH896	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH907	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH908	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
North Fork Skagit River Delta Archaeological Sites				
Fishtown Archaeological District 11	*Sqwikwikwab*, ethnohistoric village and historic town site	Eligible	Adjacent to project area	Appears that it will be affected based on current project design
45SK34	Pre-contact habitation site	Eligible: Part of archaeological district (DT11)	Extends into project area	Appears that it will be affected based on current project design
45SK35	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
45SK78	Pre-contact shell midden site	Unevaluated	Just outside of project area	Appears that there will be no effect based on current project design
45SK80	Cave with pile of shell	Unevaluated	Adjacent to project area	Appears that there will be no effect based on current project design
45SK87	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
Duckabush Estuary Archaeological Sites				
45JE362	Duckabush Orchard	Unevaluated	In project area	Potentially affected

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

**Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change.

Signatories to the PA include the Corps, the Washington SHPO, the ACHP, WDFW, and the Lummi Nation. The Lummi Nation is a signatory due to the Nooksack restoration project extending onto the reservation and because the Lummi Nation has a recognized Tribal Historic Preservation Officer (THPO) who has assumed the responsibilities of the State Historic Preservation Officer (SHPO) on tribal lands. The Washington Department of Transportation (WSDOT) is an invited signatory due to their interest in the Duckabush Bridge located in the Duckabush restoration site. For any other sites that receive authorization and funding, these will undergo a separate consultation process for compliance with NHPA.

5.3.2 Historic Buildings and Structures

5.3.2.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no immediate effect on historic buildings and structures. The built environment at sites, however, would not remain static but would continue to evolve. Adverse impacts unrelated to the Federal action that are expected to occur to some buildings and structures include non-compatible modifications, deterioration due to neglect, abandonment, and possible damage from flooding or other natural disasters. Other buildings and structures will likely be maintained and/or restored in manners consistent with the Secretary of Interior's guidelines and standards for the treatment of historic properties. The number of potential historic properties will increase as buildings and structures reach the 50-year hallmark for National Register consideration. There would be no change in the current management condition affecting historic buildings and structures; Federal actions or undertakings would continue to be reviewed in accordance with Section 106 of the NHPA.

5.3.2.2 *Alternative 2 – 11 Sites*

This alternative has potential for significant impact on historic buildings and structures. Nine of the restoration sites contain previously recorded historic structures as well as historic structures not currently recorded but known to exist. Livingston Bay contains four previously inventoried historic structures: these include the John P. and Annie Larson Farm (eligible to the NRHP), the John Hanson House (requires further evaluation), and two non-eligible structures. Dugualla Bay contains the Dugualla Lake dike and pumping system, which was reportedly constructed in the 1910s to 1920s. Deepwater Slough contains the Deepwater Slough levee system. The levee system has been recommended ineligible for inclusion on the NRHP; however, the levee system has not been formally evaluated. The Nooksack River Delta site contains 13 previously inventoried historic properties located either within the restoration site area or directly adjacent to it. Of the 13 properties, five have been determined not eligible, six are unevaluated and finally, the Marietta/Custer Grange Hall located just outside of the Nooksack River Delta area is eligible to the NRHP. The North Fork Skagit River Delta site contains an unevaluated historic granary, the unevaluated Skagit levee, and an historic farming complex that contains a barn listed on the Washington Heritage Barn Register. Two sites included in this alternative (Spencer Island and Telegraph Slough) contain levees. The Spencer Island levees have been inventoried but will need

to be formally evaluated. The Telegraph Slough levees will need to be inventoried and evaluated. The Everett Marshland site contains a historic barn, a historic bridge proposed for removal, and the Marshland Dike and Ditch System (recommended ineligible but not formally evaluated). Finally, the Milltown Island site contains a dike that has been recommended ineligible to NRHP but has not been formally evaluated. As with the archaeological sites mentioned in section 5.3.1.3, the restoration sites in this alternative, with the exception of the Nooksack River Delta and the North Fork Skagit River Delta, would undergo their own Section 106 consultation, which would include a comprehensive inventory and National Register evaluation of all built-environment resources at each site. Potential adverse impacts to National Register-eligible historic buildings and structures would be mitigated as appropriate through the Section 106 process. For the Nooksack River Delta, the North Fork Skagit River Delta, and the Duckabush River Estuary restoration sites, the Corps has prepared a PA outlining the Section 106 process that will be followed (see 5.3.1.4 for the PA process).

5.3.2.3 *Alternative 3 – 18 Sites*

Alternative 3 has greater potential impact on historic buildings and structures due to having more proposed sites. Alternative 3 contains the same historic properties as Alternative 2 but includes more historic resources at four additional sites. Four of the restoration sites in this alternative contain either previously recorded historic structures or historic structures not currently recorded but are known to exist. The Duckabush site contains the Highway 101 causeway, including two bridges. Of the two bridges on the causeway, one (the Duckabush Bridge) is listed in the NRHP. The second bridge has been inventoried and recommended ineligible but has not been formally evaluated. The Snow Creek and Salmon Creek Estuary contains a possible mill site, sections of Highway 101, and an abandoned segment of the Port Angeles & Western railway. The Tahuya River Estuary site contains a collapsed structure, a road bridge, and wood pilings. These structures have been inventoried but not formally evaluated. In addition, based on the previous land use there is a high likelihood that a sawmill may be located within the restoration area. Finally, the WDNR Budd Inlet Beach site contains the previously inventoried marine station dock that has been recommended not eligible to the NRHP. This restoration site also contains a marine laboratory and concrete bulkhead that need to be inventoried.

A comprehensive inventory and National Register evaluation of all built-environment resources at each site would need to be completed; inventory work for each site should be conducted no more than five years in advance of construction. The Corps would consult with the SHPO and other interested parties regarding future identification and evaluation strategies, and develop and implement mitigation measures prior to construction where adverse effects could not be avoided. While NHPA Section 106 compliance was initiated for this alternative during preparation of the Draft FR/EIS, the process was changed when the plan was reformulated. Any of the restoration sites that may be carried forward from this alternative under different authorities would undergo their own Section 106 consultation at a future date should they become authorized. The exceptions from this alternative are the Nooksack River Delta and the North Fork Skagit River

Delta, with the addition of the Duckabush Estuary restoration site for which the Corps has prepared a PA outlining the Section 106 process that will be followed (See section 5.3.1.4 for a description of the PA).

5.3.2.4 *Alternative 4 – 3 Sites*

This alternative has significant potential to impact resources eligible for listing to the NRHP. All three sites included in this alternative have had previous cultural resource surveys conducted within portions of the restorations sites. All three locations contain additional unrecorded structures that have not yet been surveyed and evaluated. The Corps has prepared a PA outlining the Section 106 process that will be followed (See section 5.3.1.4). Table 5-12 lists the known historic structures that are located in each of the three proposed restoration sites of the Recommended Plan.

Table 5-12. Known historic structures located in the Nooksack River Delta, North Fork Skagit River Delta, and Duckabush Estuary proposed restoration sites.

Description*	Date Constructed	NRHP Eligibility	Location	Potential Effect to Resource Based on Current Design**
Nooksack River Delta Structures				
Janet's House-1816 Bayon Road, Bellingham	1930-1950	Unevaluated-WISSAARD states undetermined-SHPO	In project area	Appears that it will be affected based on current project design
Wylanoux House (Howell House)	1912	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Kwina Slough Levee	1927	Unevaluated	In project area	Appears that it will be affected based on current project design
Nooksack River Levee	1900, 1935, 1955	Unevaluated	In project area	Appears that it will be affected based on current project design
Lummi River Levee	1900	Unevaluated	In project area	Appears that it will be affected based on current project design
Jones House-1880 Marine Drive, Bellingham		Not eligible	In side project area	No effect as house has been determined not eligible
1850 Shady Lane-Historic single family residence	1950	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Scarborough-1857 Marine Drive, Marietta	1920	Not Eligible	In project area	No effect as house has been determined not eligible
White-1853 Marine Drive, Marietta	1915	Not Eligible	In project area	No effect as house has been determined not eligible
Marietta/Custer Grange Hall	1920	Eligible	Just outside project area	Appears that there will be no effect based on current project design
1835 Marine Drive-Historic single family residence	1925	Not Eligible	In project area	No effect as house has been determined not eligible
1801 Marine Drive Historic single family residence	1949	Not Eligible	In project area	No effect as house has been determined not eligible
WH207-Boundary marker	?	Marine Drive Point Roberts	In project area	Appears that there will be no effect based on current project design
North Fork Skagit River Delta Structures				
North Fork Skagit River Levee	1935	Not Evaluated	In project area	Appears that it will be affected based on current project design

45SK337	Summers Farm Barn 1885	Washington Historic Barn Register	In project area	Appears that it will be affected based on current project design
Duckabush Estuary Structures				
Duckabush River Bridge	1934	Listed on NRHP	In project area	Adverse effect with proposed removal
Northern Distributary Channel Bridge	1934	Unevaluated	In project area	Adverse effect with proposed removal

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

** Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change.

5.4 SOCIO-ECONOMIC RESOURCES AND HUMAN ENVIRONMENT

This section discusses effects to the significant socioeconomic resources in the Nearshore Study area. The two periods considered when analyzing effects are the likely period of construction lasting approximately six months to two years depending on the scope of each site, and the 50-year period of analysis for ecosystem benefits. The spatial scale of analysis is different for each resource type as some effects would be Sound-wide and others would only occur at the site level.

5.4.1 Shoreline Ownership and Land Use

As described in detail in section 3.4.1, land uses around the nearshore zone include residential areas, public and private recreational properties, industrial sites, agricultural areas, aquaculture, and publicly and privately held boat launching sites among other uses. This section analyzes potential effects to properties at the proposed sites.

5.4.1.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no effect to shoreline ownership or land use. With no ecosystem restoration at the proposed sites, property owners may elect to install or strengthen shoreline armoring as a response to sea level change. Such modifications would further reduce natural ecosystem processes that are already degraded.

5.4.1.2 *Alternative 2 – 11 Sites*

No sites would move forward without necessary land ownership or easements in place. Three of the 11 sites are wholly or mostly in public ownership. Five of the 11 sites are wholly or mostly in private ownership. The remaining three involve a mix of public and private ownership. Many lands associated with the Nooksack River Delta are in tribal jurisdiction and would require close coordination with the Lummi Nation. Assuming landowner concerns are addressed through agreements or avoidance, project lands would become public lands or include easements to allow proposed activities to occur. Compared to Alternative 3, this alternative does not take full advantage of opportunities that could occur on public lands for high priority restoration and protection. Land use changes expected from this alternative would result from converting

agricultural lands to wetlands as well. This loss is often a necessity of ecosystem restoration, due to the fertile soils provided by riverine wetlands and the historic diking for farmland. In addition, acquisition of farmland is often easier than acquisition of more densely developed areas with residences and businesses. The amount of agricultural land that would be converted is a small fraction of the total acreage for each county where the project(s) occur and the loss of crop production would likely be absorbed by other nearby farms. Any economic losses associated with this conversion of lands would be minor and insignificant at a county scale. Individual farmers would be compensated for their loss through the purchase agreement with the local sponsor.

5.4.1.3 *Alternative 3 – 18 Sites*

As with Alternative 2, no sites could move forward without necessary land acquisition or easements in place. A significant portion of all acreage involved for this alternative occurs on publicly held lands, although some private property occurs within the site design footprints. Six of the 18 sites in this alternative are wholly or mostly in public ownership. Six other sites are wholly or mostly in private ownership and the remaining six are a mix of public and private ownership. In general, the sites that are primarily in private ownership are smaller in size and complexity. Most of the larger and more complex sites encompass an even mix of public and privately owned lands. Some properties may already have easements, or may involve property acquisition, expected to occur through purchases from willing landowners.

Many of the northern sites in areas like Skagit and Snohomish counties include lands being used for agricultural purposes, which has historically been an incompatible land use with restoration activities. Loss of farmland has been a controversial subject, with local ordinances to achieve "no net loss of farmlands." For eight of the 18 sites, agricultural land use would change to wetlands due to this restoration project. This loss is often a necessity of ecosystem restoration, due to the fertile soils provided by riverine wetlands and the historic diking for farmland. The spirit of "no net loss of farmlands" is to prevent suburban and urban development. In addition, acquisition of farmland for ecosystem restoration is often easier than acquisition of more densely developed areas with residences and businesses. The amount of agricultural land that would be converted is greater than Alternative 2, but still a small fraction of the total acreage for a given county where the project(s) occur and the loss of crop production would likely be absorbed by other nearby farms. Any economic losses associated with this conversion of lands would be minor and insignificant at a county scale. Individual farmers would be compensated for their loss during the purchasing agreement with the local sponsor.

5.4.1.4 *Alternative 4 – 3 Sites*

As with Alternatives 2 and 3, no sites would move forward without necessary land ownership or easements in place. Duckabush includes privately held, commercial, Jefferson County, and state and Federal lands (U.S. Forest Service), with public as the dominant ownership at 87% of the

total site acreage. Nooksack property types include private, commercial, Whatcom County, NFS, Bureau of Indian Affairs (BIA) lands, and Lummi Nation lands. Private ownership is approximately 50% of acreage for the Nooksack site, whereas 30% is public ownership (NFS and Whatcom County) and 20% is Tribal lands held in trust or owned by Lummi Nation. Finally, property for North Fork Skagit River includes private, commercial, Skagit County, and NFS lands, with private as the dominant ownership at 97% of the total site acreage.

Each of the three sites underwent analysis for its land use and potential conversion. Conversion of farmland to wetland is less than for Alternatives 2 and 3. The North Fork Skagit River Delta site, located in Skagit County, includes five acres used for agricultural purposes. This is less than 0.005 percent of farmland in Whatcom County. Loss of farmland has been a controversial subject, with local ordinances to achieve "no net loss of farmlands." The spirit of "no net loss of farmlands" is to prevent development. This loss is often a necessity of ecosystem restoration, due to the fertile soils provided by riverine wetlands and the historic diking for farmland. According to the Natural Resources Conservation Service (NRCS), the North Fork site is 1.8% prime farmland. The remainder of the site is comprised mainly of prime farmland if it was drained (94.9%), prime farmland if it was irrigated (0.1%), or not prime farmland (3.2%). The Duckabush River Estuary site will convert only 0.2 acres Prime and Unique Farmland and 0.2 acres of Statewide Important or Local Important Farmland, which account for less than 0.001% of farmland in Jefferson County. The Nooksack River Delta site is 43% prime farmland. The remaining 1,031.7 acres (57%) are either not prime farmland or would be prime farmland with additional modification, such as the land being drained, irrigated, or drained and either protected from flooding or not frequently flooded during the growing season. This is less than 0.01 percent of farmland in Whatcom County. These areas would be converted to wetlands or other habitat type after construction of the restoration project given the small fraction of the total farm acreage conversion for a given county where the projects occur, impacts would be minor and insignificant. Individual farmers would be compensated for their loss during the purchasing agreement with the local sponsor and the loss of crop production would likely be absorbed by other nearby farms.

5.4.2 Public Access and Recreation

Public access is important to the residents of the State of Washington and was included as an overarching policy of the 1971 Shoreline Management Act. Local communities often reflect this interest during public comment periods and design charrettes for proposed projects. Restoration and protection efforts in the nearshore zone are opportunities to improve public access and recreation in areas that may have had limited or informal access before. A challenge with public access and recreation opportunities for the Nearshore Study is to make sure it meets the needs of the user groups for an area and still allows for process-based ecosystem restoration at a site. To achieve both goals, in some instances, access sites or recreational features must be relocated.

5.4.2.1 *Alternative 1 – No-Action Alternative*

The No-Action Alternative would have no addition or subtraction of public access points to the shoreline. Many of Puget Sound's recreation opportunities rely on natural resources such as whale watching, bird watching, fishing, and shellfishing, as described in section 3.4.2. Aspects of each of these resources are in decline throughout the region, and to take no action toward restoring nearshore ecosystem processes would mean that these downward trends could continue. Loss of the natural resources that are the target of recreational activities would lead to decline in numbers of individuals participating in those activities. Not only would this have an immeasurable impact on families whose traditions surround these activities, but this would also have the indirect effect of decreasing revenue to the local and regional economies that rely on sales of goods and services related to recreational activities.

5.4.2.2 *Alternative 2 – 11 Sites*

Alternative 2 would not significantly affect long-term public access. During construction activities, some access and recreation sites may be temporarily closed. Dike-top trails associated with two of the 11 sites would replace existing conditions for walking and bird watching; there would be no expenditure toward addition of public recreation features in this alternative. Restoration of 5,348 acres of tidal wetlands would support fish and wildlife species and associated recreational opportunities such as increased bird watching opportunities; the increased salmon habitat could be presumed to assist with recovery of diminished populations thereby adding potential for increased sportfishing. Finally, there is a chance for potential displacement or substitution of recreation opportunities associated with this alternative. Waterfowl hunting opportunities may be displaced by new or different recreation opportunities (e.g., bird watching) at some of the sites included in this alternative, and two marinas would be removed. These are Blake's Marina (a small recreational marina) on the North Fork of the Skagit River and Twin Bridges Marina as part of the Telegraph Slough restoration site. There are eight other marinas within a 10-mile radius of these two marinas, which indicates ample locations for boat storage and launching.

5.4.2.3 *Alternative 3 – 18 Sites*

Alternative 3 would improve public access to the shoreline. During construction activities, some access and recreation sites may be temporarily closed. Many of the sites include work that would make visiting the shoreline easier, and a more enjoyable experience for those who value natural shorelines. The proposed activities at the Point Whitney Lagoon site would increase beach area available for public and tribal access by removing infrastructure and fill, and relocating the parking area off the spit. Pedestrian beach access would be maintained but would require walking from an upland parking area. The Snow Creek and Salmon Creek Estuary site would include a pedestrian trail feature that would replace an abandoned railroad grade that some use for walking and birding activities. This new segment of trail would serve as a portion of the proposed 130-mile long, multi-purpose, Olympic Discovery Trail that will eventually extend

from Port Townsend to the Pacific Ocean. Two other sites include dike-top trails in which restoration work would replace existing conditions and would support activities such as walking and bird watching. The Harper Estuary site would involve relocation of a boat launch. The overall restoration of 5,517 acres of tidal wetlands would have the same types of associated recreational opportunity increases as Alternative 2, but to a greater extent. Finally, there is a chance for potential displacement or substitution of recreation opportunities associated with this alternative. Waterfowl hunting opportunities may be displaced by new or different recreation opportunities (e.g., bird watching) at some of the sites included in this alternative, and two marinas would be removed. These are Blake's Marina on the North Fork of the Skagit River and Twin Bridges Marina as part of the Telegraph Slough restoration site.

5.4.2.4 *Alternative 4 – 3 Sites*

Alternative 4 would not improve public access to the shoreline. During construction activities, some access and recreation sites may be temporarily closed. There would be no expenditure toward addition of public recreation opportunity in this alternative. Restoration of tidal wetlands at Duckabush would support fish and wildlife species and associated recreation such as increased bird watching opportunities; the increased salmon habitat could be presumed to assist with recovery of diminished populations thereby adding potential for increased sportfishing. Finally, there is potential for displacement or substitution of recreation opportunities associated with this alternative: Blake's Marina, which consists of a 120-foot day-use dock, a 500-foot overnight-use dock and a boat ramp, all located within the North Fork Skagit River site would be removed. The lower Skagit River has other nearby launch sites that would absorb the low volume of vessel traffic.

5.4.3 Commercial Fisheries and Aquaculture

The Puget Sound offers an unparalleled opportunity for commercial harvest of marine species, which supports a lucrative industry that caters to customers around the world. Improving, or at a minimum, maintaining harvest levels is imperative for sustaining this sector of the economy and has a direct influence on the quality of life for residents who earn their living in this sector.

5.4.3.1 *Alternative 1 – No-Action Alternative*

Commercial fisheries for finfish have been declining in recent years while commercial shellfish harvests have been relatively stable. The No-Action Alternative may have a negligible effect that continues the decline of commercially harvested species, especially salmon. Additionally, this alternative would maintain degraded conditions that have reduced shellfish growing habitat. Sediment transport processes would remain inhibited. Moreover, this alternative would fail to provide the important water filtration afforded by increased wetlands, which is critical to keeping uncontaminated shellfish beds. This alternative could have indirect economic consequences to commercial fisheries and aquaculture due to failure to improve conditions for these species.

5.4.3.2 *Alternative 2 – 11 Sites*

Alternative 2 would provide significant benefits to salmon rearing habitat, which assists with population recovery. Removal of armoring, tidal barriers, and artificial fill in river deltas, embayments, and beaches would provide more shallow water habitat for juvenile salmon migration, increase eelgrass beds that are critical nursery areas, and provide more spawning beaches for forage fish, an important prey item for salmon. Benefits to multiple aspects of salmon ecology would assist with recovery of this important commercially harvested resource.

The shellfish aquaculture industry has been expanding operations into available suitable habitat around Puget Sound. Restoring important ecosystem processes of the nearshore zone could help to restore important landforms such as beaches and mudflats, and could help enhance and expand areas available for shellfish growing. Dugualla Bay supported native oyster populations before it was diked; restoration at the site may allow recolonization by native oysters. Removal of shoreline armoring and tidal barriers would benefit clams, oysters, and crabs by increasing sediment delivery and appropriate grain size distribution. Two of the 11 sites in this alternative have geoduck, Dungeness crab, hard clam, and oyster populations in close enough proximity that they might experience direct benefits.

5.4.3.3 *Alternative 3 – 18 Sites*

Benefits of Alternative 3 would be similar to those in Alternative 2, but to a greater extent due to having a substantially longer length of stressors removed, creating more acreage for invertebrates to colonize. This opportunity includes the potential shellfish production benefits at the Tahuya River Estuary and Point Whitney Lagoon sites. Proposed activities at the Tahuya River Estuary site are anticipated to improve shellfish production in the lower estuary by increasing transport of coarse material downstream. The Point Whitney Lagoon site supports a native oyster population within the lagoon as well as tribal commercial, ceremonial, and subsistence and public recreational harvest on tidelands. While there is concern regarding reduced infrastructure as well as a change to hydraulics and salinity to support shellfish aquaculture at this site (i.e., compatibility of restoration efforts with ongoing shellfish production activities), negative impacts can be largely avoided with proper planning, and a long-term increase in shellfish may be realized. Five of the 18 sites in this alternative have geoduck, Dungeness crab, hard clam, and oyster populations in close enough proximity that they might experience direct benefits.

5.4.3.4 *Alternative 4 – 3 Sites*

Benefits of Alternative 4 would be similar to those described for Alternatives 2 and 3 but to a lesser extent due to having substantially less acreage of wetland restoration and shorter length of shoreline armoring removal. Removal of armoring, tidal barriers, and artificial fill at the North Fork Skagit River Delta would provide significant benefits to salmon rearing habitat, which assists with population recovery. The next design phase for the Nooksack River Delta site will require careful attention to plans for diversion of flow from the Nooksack River to the Lummi

River to ensure no negative effects occur to the shellfish operations in the estuary. Impacts from restoration of sediment transport process to shellfish habitat at the Duckabush estuary will be taken into careful consideration during the next phase of design for short-term and long-term effects. Negative effects to shellfish will be avoided to the maximum extent practicable.

5.4.4 Transportation

The areas of analysis for impacts to transportation are each restoration site. This scale is selected because none of the 18 proposed sites individually or collectively would affect broad-scale transportation issues in the Nearshore Study area, but individual sites could affect localized traffic around their community. Many of the proposed sites would affect transportation infrastructure, mainly because this is one of the major stressors that has caused degradation to the nearshore environment. In general, transportation components of the proposed sites involve lengthening roadway bridges to restore ecosystem processes to function as they did in historical nearshore conditions. Table 5-13 provides a summary of the transportation infrastructure that would be modified for each of the 18 proposed sites in the final array of alternatives.

Table 5-13. Transportation Infrastructure Affected

Site	Transportation Infrastructure
Beaconsfield Feeder Bluff	• None
Big Beef Creek Estuary	• Lengthen Seabeck Highway NW bridge and realign roadway
Deepwater Slough	• None
Deer Harbor Estuary	• Lengthen Channel Road Bridge and realign roadway
Duckabush River Estuary	• Construct new Highway 101 bridge, and raise and realign highway • Construct new raised interchange at intersection of Duckabush Road, plus a private drive to north of Duckabush Road and Highway 101 • Construct new bridge at Shorewood Road
Dugualla Bay	• Lengthen Highway 20 bridge and realign highway • Lengthen Dike Road bridge and realign roadway
Everett Marshland	• Construct two new bridges on Lowell-Snohomish Road and realign roadway • Lengthen BNSF Railway bridge
Harper Estuary	• Construct new bridge at SE Olympiad Drive
Livingston Bay	• None
Milltown Island	• None
Nooksack River Delta	• Construct new bridge on Ferndale Road and realign roadway • Construct new bridge on Slater Road and realign roadway at Lummi River • Construct new bridge on Slater Road over Tennant Creek • Raise portions of Slater Road and Marine Drive • Construct new bridge on Hillaire Road and realign roadway • Construct new bridge on Imhoff Road and realign roadway • Construct new bridge on Haxton Way and realign roadway
North Fork Skagit River Delta	• None

Point Whitney Lagoon	• None
Snow Creek and Salmon Creek Estuary	• Lengthen Highway 101 bridge and realign highway • Remove abandoned railway bridge and embankment
Spencer Island	• None
Tahuya River Estuary	• Lengthen NE North Shore Road bridge and realign roadway • Relocate helipad
Telegraph Slough	• Lengthen Highway 20 bridge and realign highway • Lengthen BNSF Railway
WDNR Budd Inlet Beach	• None

Bridge construction costs are classified as Lands, Easements, Rights-of-way, Relocations, and Disposal areas (LERRDs).

5.4.4.1 *Alternative 1 – No-Action Alternative*

Under the No-Action Alternative, transportation infrastructure within the nearshore environment would not be replaced or modified. The roads, highways, bridges, and lengths of railway in the area of analysis would deteriorate as they age, requiring continued maintenance and repair. Some of this infrastructure within the zones of tidal influence may need to be modified in response to sea-level changes associated with climate change.

5.4.4.2 *Alternative 2 – 11 Sites*

Alternative 2 would involve the replacement and/or modification of transportation infrastructure including roadways and bridges to restore nearshore ecosystem processes. This proposal involves modification of transportation infrastructure at five of the 11 sites. These modifications involve seven road bridge sites including three new bridges and associated road realignments as well as reconstruction of two railway bridges. Detour routes and/or temporary structures would be developed to ensure that vehicle and rail traffic can still pass through sites during construction. Since designs are at the conceptual level, it is not yet possible to estimate duration of construction or the detour route. During the construction period, drivers may experience inconvenience due to traffic detours, but when completed, transportation infrastructure would be back in place and traffic would flow as normal.

5.4.4.3 *Alternative 3 – 18 Sites*

Alternative 3 would involve the replacement and/or modification of transportation infrastructure including roadways, bridges, and rail lines and associated bridges, to restore nearshore ecosystem processes. Alternative 3 involves modifying transportation infrastructure at 10 proposed sites, including constructing 19 bridges (10 new and nine reconstructions) and associated road realignments, and two railway bridge sites. In addition, one abandoned railway site (a bridge with embankment) would be removed.

5.4.4.4 *Alternative 4 – 3 Sites*

Alternative 4 would involve the replacement and/or modification of transportation infrastructure including roadways and bridges to restore nearshore ecosystem processes. This proposal involves modification of transportation infrastructure at two of the three sites. These modifications involve two new bridges for the Duckabush site, one of which replaces a culvert at Shorewood Road. Most of the new construction on Highway 101 can take place with the old roadway in place and in use; however, there would be a period when constructed approaches or culvert replacements would result in temporary interruptions to traffic. Additionally, a temporary roadway at Duckabush Road would likely be constructed to provide ingress-egress from the river valley. Annual average daily traffic counts for Highway 101 at Duckabush Road is 2,200 as of 2014 (WSDOT 2014). The Nooksack River Delta site includes construction of six new bridges, realignment of roads, and raising portions of Slater Road and Marine Drive as well as raising Ferndale Road onto a setback levee. Roads within the Nooksack site are all rural, local roads. Some of the road construction in the Nooksack Delta would result in detours or temporary interruptions to traffic. No transportation impacts are anticipated with the North Fork Skagit River Delta site. Detour routes and/or temporary structures would be developed to ensure that vehicle traffic can still pass through sites during construction. During the construction period, drivers may experience inconvenience due to traffic detours, but when completed, transportation infrastructure would be back in place and traffic would flow as normal.

5.4.5 Public Safety

NEPA requires that public safety be considered in the alternatives analysis of Federal proposals. The Corps anticipates no reduction in public safety from the proposed project as all applicable laws, regulations, and codes will be complied with during design and construction phases.

5.4.5.1 *Alternative 1 – No-Action Alternative*

Under the No-Action Alternative, public safety infrastructure within the nearshore environment would not be modified or improved and will require ongoing maintenance and repair. Levees are typically under the responsibility of local diking districts or counties that provide maintenance. The Corps would not alter any levees for ecosystem restoration under the No-Action Alternative; any changes to these levees for public safety are and would continue to be the responsibility of the levee owners. Transportation infrastructure and utilities in the study area such as bridges, roads, railroads, conduits and pipelines would require continued maintenance, repair, or replacement to insure public safety.

5.4.5.2 *Alternative 2 – 11 Sites*

For any management measures or site features that may be relevant to public safety, the Corps would apply all current engineering and design regulations to achieve no reduction in any aspects of public safety.

Alternative 2 would involve the replacement and/or modification of various components of infrastructure that have public safety criteria including armoring, utilities, roads, bridges for vehicles or trains, and levees. As described in section 4.6, for each of the restoration sites in which the Corps is proposing to breach a levee and construct a new levee, the new levee will maintain the same level of residual flood risk as the levee it is replacing. Alternative 2 includes five sites in which a new or setback levee would be constructed to protect public or private property from inundation that could result from the restoration work. This alternative includes two sites, Beaconsfield Feeder Bluff and Dugualla Bay, where existing shoreline armoring is proposed for removal. Neither project would have any effect on public safety as the sites would be designed to prevent any new or additional risk.

This proposal involves modification of road alignments at four of the 11 sites: Deer Harbor Estuary, Dugualla Bay, Everett Marshlands, and Nooksack River Delta. Each modification would conform to current road design safety standards applicable to the type and size of roadway being modified. There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety.

Alternative 2 includes twelve road bridges and reconstruction of two railway bridges. One of these bridges is a section of Highway 20 at Telegraph Slough. Each modification would conform to current bridge design safety standards applicable to the type and size of bridge being modified. There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety and will allow for predicted sea level change.

Alternative 2 contains two sites that would affect utility corridors. These are along State Route 20 at the Telegraph Slough site and at the Everett Marshland with work within the Lowell-Snohomish River Road prism. The Corps anticipates no impacts to public safety and the resulting project may actually improve conditions relevant to public safety as all modifications would conform to current design safety standards.

One benefit of wetland restoration is increased usage by waterfowl; however, bird and other wildlife that are attracted to wetlands can pose a risk to air traffic. The Dugualla Bay site is approximately one mile east of Ault Field, part of Naval Air Station Whidbey Island. The proposed restoration at this site would change the site from a freshwater lake to an estuary connected to Skagit Bay. According to the Navy's Bird/Animal Aircraft Strike Hazard (BASH) program, there are a variety of measures that help minimize risk to aircraft from bird and animal strikes. The Corps would work closely with the Navy and the BASH program manager to ensure that any change in bird usage of the tidal area is in compliance with the BASH program.

5.4.5.3 *Alternative 3 – 18 Sites*

Alternative 3 would involve the replacement and/or modification of a greater number than Alternative 2 of components of infrastructure that have public safety criteria including roadways, bridges, and levees to restore nearshore ecosystem processes.

Alternative 3 contains the same five sites as Alternative 2 with new levees, and no additional sites in which levees would be constructed. The same is true for the need for utility relocations; Alternative 3 has no additional sites that affect major utility corridors beyond those already discussed for Alternative 2.

There are two additional sites in Alternative 3 that involve armoring that would be removed. At the Snow Creek and Salmon Creek estuary, the armoring removal would not threaten any infrastructure. Removal of armor at Big Beef Creek Estuary is associated with the bridge proposed for replacement. The new bridge would have all appropriate protection measures required for new construction.

Alternative 3 involves modifying one additional road alignment other than the three included in Alternative 2. This involves permanent removal of approximately 425 feet of SE Olympiad Drive and associated fill that is bisecting the freshwater marsh and saltwater estuarine area at Harper Estuary. Closure of this section of road would require a traffic analysis assessing impacts to local residences and emergency services to maintain the same level of public safety.

This alternative includes constructing 19 bridges (10 new and nine reconstructions) and three railway bridges. Two of these bridges are sections of Highway 101, at the Duckabush River estuary and at the Snow Creek and Salmon Creek estuary. Transportation infrastructure would meet all current safety criteria and designs will allow for predicted sea level change. Alternative 3 does not include any additional sites where wetland restoration is proposed near an airfield.

5.4.5.4 *Alternative 4 – 3 Sites*

Alternative 4 would involve the replacement and/or modification of various components of infrastructure that have public safety criteria including armoring, utilities, roads, bridges for vehicles or trains, and levees. For each of the restoration sites in which the Corps is proposing to breach a levee and construct a new levee, the new levee will maintain the same level of residual flood risk as the levee it is replacing. Alternative 4 includes two sites (Nooksack and North Fork) in which levee breaching or removal for ecosystem benefits necessitates construction of new levees. New levees would protect public or private property from inundation that could result from the restoration work. Neither project would have any effect on public safety as the sites would be designed to prevent any new or additional risk.

This proposal involves modification of road alignments at two sites: Duckabush River Estuary and Nooksack River Delta. Each modification would conform to current road design safety

standards applicable to the type and size of roadway being modified. There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety.

Alternative 4 includes seven road bridge replacements: two at Duckabush and six at Nooksack. Each modification would conform to current bridge design safety standards applicable to the type and size of bridge being modified. There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety and will allow for predicted sea level change.

Alternative 4 would not affect any major utility corridors. Further site analysis would occur during PED to ensure no loss of services to the public. The Corps anticipates no impacts to public safety and the resulting project may actually improve conditions relevant to public safety as all modifications would conform to current design safety standards. This alternative does not include any sites where wetland restoration is proposed near an airfield.

5.5 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This section summarizes the expected effects on significant environmental resources described in preceding sections. Table 5-14 provides a summary of these effects in comparative format. In addition to the comparison of environmental effects of the alternatives, NEPA requires consideration of certain other aspects of any Federal project requiring an EIS (40 CFR 1502.16). These include the following:

- Adverse environmental effects that cannot be avoided should the proposal be implemented
- The relationship between short-term uses of the human environment and the maintenance and enhancement of long-term biological productivity
- Any irreversible or irretrievable commitments of resources
- Any areas of controversy and unresolved issues

The *adverse environmental effects that cannot be avoided* are all of the remaining effects after avoidance and minimization measures have been employed. Remaining potential effects are in two categories: cultural resources and aquatic animals affected by underwater noise. Implementing the restoration action would result in unavoidable adverse effects to cultural resources as detailed in section 5.3. For any restoration site that becomes authorized, the Corps would consult with the SHPO, ACHP, THPO, and tribes on appropriate mitigation measures on a case-by-case basis according to the PA to achieve full compliance with the NHPA. Finally, underwater noise during construction may cause unavoidable harm to a few aquatic animals at the individual level, but not at the population level (See section 5.7 for mitigation measures).

The *short-term uses of the human environment* would ultimately benefit the maintenance and enhancement of long-term productivity of the ecological resources of the Puget Sound region.

Some of the short-term uses of resources would include a temporary closure of some public access points for the duration of construction, and some land would be cleared for access and staging. There would be no long-term negative effects to productivity; in fact, the purpose is to restore the natural processes that support productivity and the resilience of the ecosystem to support biological resources that humans value. A net increase in vegetation would result in an increase in primary biological productivity and could increase capacity for carbon sequestration.

The *irreversible or irretrievable commitments of resources* would involve energy and materials for removal of stressors and rebuilding of critical infrastructure that must be replaced. The irretrievable commitment of resources would largely be due to the construction materials required for modification of critical infrastructure including any highway realignments, bridge replacements, and road relocations. As shown in the GHG emissions analysis, Alternative 2 would burn approximately 6.7 million gallons of diesel fuel resulting in 74,000 tons of CO_2 emissions. Alternative 3 would involve more diesel and related emissions at approximately 7.4 million gallons of diesel fuel burned resulting in 82,000 tons of CO_2 emissions. Alternative 4 would burn less diesel at approximately 3 million gallons and would have 33,000 tons of CO_2 emissions. The historical structures and archaeological sites at the restoration sites are cultural resources that are non-renewable and would be either removed (structures), buried, or destroyed (archaeological sites) to successfully restore ecosystem processes. The impact to structures and artifacts is an irreversible commitment of these resources. For any unavoidable adverse effects (removal or destruction) to National Register-eligible historic properties, the Corps will consult on a case- by-case basis to identify necessary mitigation measures from the list included in the PA with the SHPO, ACHP, THPO, tribes, and other interested parties.

There are no *areas of controversy or unresolved issues* among the Federal, state, or local agencies consulted during this project. Some controversy arose through individual property owners who voiced concerns regarding potential effects to their properties that may result from the proposed restoration. During feasibility phase, hydraulic engineers performed an analysis to determine probability of risk to potentially affected properties. Site design during PED would take landowner concerns into account—reflected by design modifications—and sites would only go forward after landowner concerns have been addressed. Any unresolved cultural resources issues will be resolved through the procedures described in the PA.

The Corps is continuously considering project impacts to Native American Tribes and the benefits and risks associated with the proposed restoration actions. In addition to the potential effects to cultural resources discussed in section 5.3, there may be temporary impacts to shellfish beds and fishing during construction of the preferred alternative. Restoration is generally encouraged by tribes and the Corps has support from many tribes specifically for the Nearshore Study. The Corps plans to continue consultation and coordination with affected tribes throughout the process to ensure the project avoids any interruptions to tribal fisheries, impacts to shellfish are minimized, and all other tribal resources are considered during design phase.

Table 5-14 Summary of Environmental Consequences

		ALTERNATIVE 1 No Action	ALTERNATIVE 2 11 Sites	ALTERNATIVE 3 18 Sites	ALTERNATIVE 4 3 Sites
PHYSICAL ENVIRONMENT: NEARSHORE PROCESSES & STRUCTURE					
Nearshore Processes	Short-Term Construction Effects	N/A	Immediate removal of stressors, some immediate restoration of processes.	Immediate removal of stressors, some immediate restoration of processes.	Immediate removal of stressors, some immediate restoration of processes
	Long-Term Project Effects	Continued decline of ecosystem function due to impaired processes.	Restores target processes with improved ecosystem functions on 5,348 acres of wetlands. Restores 5.5 acres of sediment delivery on a beach.	Restores target processes with improved ecosystem functions on 5,517 acres of wetlands. Restores 7.5 acres of sediment delivery on beaches.	Restores target processes with improved ecosystem functions on 2,101 acres of wetlands. No beach sites are included.
Geologic and Physiographic Setting	Short-Term Construction Effects	N/A	Immediate removal of 75,162 feet of shoreline stressors.	Immediate removal of 113,094 feet of shoreline stressors.	Immediate removal of 28,860 feet of shoreline stressors
	Long-Term Project Effects	Continued influence of artificial laudforms. Continued decrease in length and complexity of the shoreline	Increases shoreline leugth by 131,578 feet over existing 11 sites. The resulting length would be 166% of the existing length.	Increases shoreline length by an additional 125,474 feet over existing 18 sites. The resulting length would be 147% of the existing length.	Increases shoreline length by 23,568 feet over existing 3 sites. The resulting length would be 132% of the existing length.
Oceanography	Short-Term Construction Effects	N/A	Medium amount of localized and temporary impacts to currents due to temporary work structures. Immediate benefits of freshwater inputs and distributary channels at 10 of 11 sites.	Greatest amount of localized and temporary impacts to currents due to temporary work structures. Immediate benefits of freshwater inputs and distributary channels at 16 of 18 sites.	Least amount of localized and temporary impacts to currents due to temporary work structures. Immediate benefits of freshwater inputs and distributary channels at all 3 sites.
	Long-Term Project Effects	No oceanography effects. Dikes iu river deltas will continue to channelize fresh water input and inhibit freshwater mixing.	Restoration of 5,348 acres of tidally influenced wetlands. Freshwater influeuce restored at 5 of 11 sites.	Restoration of 5,517 acres of tidally influenced wetlands. Freshwater influence restored at 10 of 18 sites.	Restoration of 2,101 acres of tidally influenced wetlands. Freshwater influence restored at all 3 sites
Water Quality	Short-Term Construction Effects	N/A	Same effects as Alternative 3, but less risk due to smaller number and size of projects.	Risk of fuel spill and encountering undocumented sources of contaminants. Tidal inundation of farmland with short-term releases fecal col., turbidity, Dissolved Oxygen, nutrients.	Same effects as Alternative 3, but less risk due to smaller number and size of projects.

Water Quality	Long-Term Project Effects	Water quality will continue to vary based on local, natural, and anthropogenic stressors.	Potential improvement in water quality due to 5,348 acres of wetlauds added. Benefits similar to Alternative 3, bnt smaller magnitude due to smaller number and size of sites.	Potential improvement in water quality due to 5,517 acres of wetlands added. Added riparian shading would lower water temperatures.	Potential improvement in water quality due to 2,101 acres of wetlands added. Similar benefits to Alternatives 2 and 3, but to a lesser extent.
Sedimentation & Erosion	Short-Term Construction Effects	N/A	Release of sediment from excavation and stressor removal.	Release of sediment from excavation and stressor removal, to a greater extent than Alternative 2 and 4.	Release of sediment from excavation and stressor removal, to a much lesser extent than Alternatives 2 and 3.
	Long-Term Project Effects	Remain inpaired due to stressors such as shoreline armoring.	Restored sediment delivery and transport due to removal of 77,796 linear feet of stressors.	Restored sediment delivery and transport due to removal of 115,718 linear feet of stressors.	Restored sediment delivery and transport due to removal of 28,860 linear feet of stressors.
HTRW	Short-Term Construction Effects	N/A	None; HTRW sites will either be avoided, or cleaned up by non-Federal sponsor.	Same as Alternative 2.	Same as Alternative 2.
	Long-Term Project Effects	N/A	None; HTRW sites will either be avoided, or cleaned up by non-Federal sponsor.	Same as Alternative 2.	Same as Alternative 2.
Greenhouse Gas Emissions	Short-Term Construction Effects	N/A	Estimated 74,053 tons of GHG emissions from construction activities.	Estimated 82,276 tons of GHG emissions from construction activities.	Estimated 33,379 tons of GHG emissions from construction activities.
	Long-Term Project Effects	N/A	GHG absorption expected (less than Alternative 3) as vegetation establishes; difficult to estimate.	GHG absorption expected as vegetation establishes; may offset construction effects.	GHG absorption expected (less than Alternative 3) as vegetation establishes; difficult to estimate.
Underwater Noise	Short-Term Construction Effects	N/A	5 projects have noise-producing activities that may cause behavior disruption or harm to aquatic species.	10 projects have noise-producing activities that may cause behavior disruption or harm to aquatic species.	2 projects have noise-producing activities that may cause behavior disruption or harm to aquatic species.
	Long-Term Project Effects	N/A	Low likelihood for harm to birds or marine mammals, or loss of few fish in close proximity to pile driving.	Greater likelihood for harm to birds or marine mammals, or loss of few fish in close proximity to pile driving.	Very low likelihood for harm to birds or marine mammals, or loss of fish in close proximity to minor pile driving for removal.

		ALTERNATIVE 1 No Action	ALTERNATIVE 2 11 Sites	ALTERNATIVE 3 18 Sites	ALTERNATIVE 4 3 Sites
BIOLOGICAL ENVIRONMENT: NEARSHORE FUNCTIONS					
Vegetation	Short-Term Construction Effects	N/A	Similar impacts to those described for Alternative 3, but to a lesser extent due to fewer and smaller projects.	Temporary turbidity disturbance to kelp, eelgrass, and nearby wetlands. Riparian vegetation would be removed from structures being removed.	Similar impacts to those described for Alternative 3, but to a much lesser extent due to fewer and smaller projects.
	Long-Term Project Effects	Marine and riparian vegetation would stay limited by poor sediment delivery and shading by overwater structures. Tidal wetlands would remain constrained by fill and dikes.	Less freshwater marsh loss than Alternative 3, but less tidal wetlands restored and less riparian planting. Less benefit to kelp and eelgrass due to less length of stressors removed than Alternative 3.	Minor conversion of freshwater to saltwater marsh plants from restoring tidal inundation. 5,517 acres of tidal wetlands restored. Riparian planting at several projects. Sediment delivery benefits to eelgrass and kelp.	Less freshwater marsh conversion than Alternative 3, but less tidal wetlands restored and less riparian planting. No direct benefits to eelgrass and kelp.
Shellfish & Other Macro-invertebrates	Short-Term Construction Effects	N/A	Similar to those described for Alternative 3, but to a lesser extent due to less bottom disturbance and less dredging.	Temporary increases in turbidity, due to dredging and excavation may cause disturbance to benthic and epibenthic communities.	Similar to those described for Alternative 3, but to a lesser extent due to less bottom disturbance and no dredging.
	Long-Term Project Effects	Lack of habitat in diked and filled intertidal areas, poor substrate supply, and siltation and pollution from run-off would continue to limit shellfish and other invertebrates.	Similar to those described for Alternative 3, but to a smaller extent due to less area of estuarine habitat restored and shorter length of shoreline stressors removed.	Transition to brackish guild where tidal inundation is restored. Benefits to eelgrass support invertebrate diversity. Armor removal and riparian plants benefit upper intertidal and backshore invertebrates.	Similar to those described for Alternative 3, but to a much smaller extent due to less area of estuarine habitat restored and a much shorter length of shoreline stressors removed.
Fish	Short-Term Construction Effects	N/A	Similar to those described for Alternative 3, but to a smaller extent due to less excavation, less pile driving, and less dredging.	Turbidity from excavation and dredging, and noise and vibration from pile driving could cause animals to flee, delay migration, or cause physical harm.	Similar to those described for Alternative 3, but to a much smaller extent due to less excavation, no pile driving other than testing, and no dredging.
	Long-Term Project Effects	Fish would remain limited by lack of estuarine habitat for them and their prey due to filled and diked	5,348 acres of estuarine habitat restored for anadromous fish rearing and foraging. Removal of shoreline stressors creates shallow water habitat for	Similar to those described for Alternative 2, but to greater extent due to more estuarine habitat restored and longer length of stressors removed.	Similar to those described for Alternative 2, but to a smaller extent due to less estuarine habitat restored and shorter length of stressors removed.

		wetlands, and lack of shallow water habitat and spawning substrate along armored shorelines.	migration corridors, spawning beaches, and benefits kelp and eelgrass.		
Birds	Short-Term Construction Effects	N/A	Disturbance from noise from pile driving and operation of heavy equipment.	Similar Alternative 2, but to a greater extent due to more pile driving and heavy equipment.	Similar Alternative 2, but to a much smaller extent due to less pile driving and heavy equipment.
	Long-Term Project Effects	Birds would remain limited by lack of estuarine foraging habitat. No effect to migratory species that use farm fields.	Additional foraging opportunities due to the 5,348 acres of restored estuarine habitat. Transition from freshwater species to brackish guild.	Similar to those described for Alternative 2, but to a greater extent due to more estuarine habitat being restored.	Similar to those described for Alternative 2, but to a much smaller extent due to less estuarine habitat being restored.
Mammals	Short-Term Construction Effects	N/A	Pile driving noise may disturb marine mammals in locating prey, flee response, or temporary hearing loss.	Similar to those described for Alternative 2, but to a greater extent due to more pile driving.	Very little disturbance to marine mammals anticipated due to almost no pile driving.
	Long-Term Project Effects	Marine mammals dependent on nearshore species would continue to suffer from lack of habitat for their prey.	Added prey base, including forage fish and salmonids, due to the increase in quantity and quality of habitat for these prey species.	Similar to those described for Alternative 2, but to a greater extent due to more new estuarine habitat created for their prey.	Similar to those described for Alternative 2, but to a much smaller extent due to less new estuarine habitat created for their prey.
Invasive Species	Short-Term Construction Effects	N/A	Less vegetative ground cover for a short duration; overall benefit to stop the spread of invasive species.	Invasive removal similar to Alternative 2, although to a greater degree due to more sites.	Invasive removal similar to Alternative 2, although to a lesser degree due to fewer sites.
	Long-Term Project Effects	Invasive species would continue to exploit human-made structures and outcompete native species.	Would result in planting and natural repopulation with native species; would stop the spread from these sources.	Same as those described for Alternative 2, but to a greater extent due to the removal of more invasive vegetation.	Same as those described for Alternative 2, but to a lesser extent due to the removal of invasive vegetation at fewer sites.
Rare, Threatened, and Endangered Species	Short-Term Construction Effects	N/A	Same effects as described for fish, birds, and mammals - primarily from turbidity and noise from excavation and pile driving.	Same as those described for Alternative 2, but to a greater extent due to more excavation and pile driving.	Same as those described for Alternative 2, but to a lesser extent due to less excavation and almost no pile driving.

	Long-Term Project Effects	Filled, diked, and armored shoreline would continue to limit salmonid rearing and forage fish (preferred prey) habitat. Lack of suitable prey habitat would continue to limit food sources for ESA species.	Listed salmonids would benefit from restored estuaries. Shallow water habitat created by removing shoreline armoring would enhance migration corridors. Higher trophic level species benefit from restored habitat of their prey base.	Same as those described for Alternative 2, but to a greater extent due more estuarine habitat being restored and sites where there are more ESA-listed species that would benefit from stressor removal.	Same as those described for Alternative 2, but to a much smaller extent due less estuarine habitat being restored and fewer total sites for ESA-listed species that would benefit from stressor removal.
		ALTERNATIVE 1 No Action	**ALTERNATIVE 2 11 Sites**	**ALTERNATIVE 3 18 Sites**	**ALTERNATIVE 4 3 Sites**
CULTURAL RESOURCES					
Archaeo-logical Resources	Short-Term Construction Effects	N/A	Potential to affect or encounter known or unknown archaeological resources.	Same as Alternative 2, although to a greater degree due to larger number and size of sites.	Potential to affect both known and unknown archaeological site located in each restoration site. Mitigation would follow the PA (Appendix D).
	Long-Term Project Effects	Future development could impact both known and unknown archaeological resources.	Work would affect 32 known archaeological sites at several restoration sites. Risk of adverse effect to National Register-eligible sites due to projects. Mitigation measures chosen and implemented per the PA will mitigate the adverse effect. Mitigation measures have the potential to contribute information to regional understanding of pre-history and history of the Pacific Northwest.	Same as Alternative 2, although to a greater degree due to larger number and size of restoration sites.	Potential to affect both known and unknown archaeological site located in each restoration site. Mitigation would follow the PA (Appendix D).
Historic Buildings & Structures	Short-Term Construction Effects	N/A	Access to any NRHP structures on site would be limited during construction.	Same as Alternative 2.	Same as Alternative 2. Mitigation would follow the PA (Appendix D).
	Long-Term Project Effects	Future developments would likely result in both adverse and positive impacts to	Loss of historic properties including levees, residential and agricultural structures (i.e. historic barns, granary, and residences) sections of railroad	Same as Alternative 2, with potential impacts to additional historic properties including, the National Register listed	Work may affect historic buildings/structures and levees located in each restoration area including the Duckabush Bridge.

		historic buildings and structures.	line, bridges, dike systems, marine laboratory, and many agricultural and residential buildings. Potential benefits would result from mitigation and or documentation measures outlined in the PA.	Duckabush Bridge, and marine laboratory.	Mitigation would follow the PA (Appendix D).
		ALTERNATIVE 1 No Action	**ALTERNATIVE 2 11 Sites**	**ALTERNATIVE 3 18 Sites**	**ALTERNATIVE 4 3 Sites**
SOCIO-ECONOMIC RESOURCES					
Shoreline Ownership & Land Use	Short-Term Construction Effects	N/A	Property purchase or construction easements from and owners will need to occur prior to construction.	Property purchase or construction easements from land owners will need to occur prior to construction.	Property purchase or construction easements from land owners will need to occur prior to construction.
	Long-Term Project Effects	No change to shoreline ownership and land-use except by regulatory mechanisms.	Permanent increase in publicly owned lands and/or changes of land use to conservation easement.	Permanent increase in publicly owned lands and/or changes of land use to conservation easement across greater area than Alternative 2.	Permanent increase in publicly owned lands and/or changes of land use to conservation easement.
Public Access & Recreation	Short-Term Construction Effects	N/A	Present access and recreation opportunities may be temporarily limited or closed during construction.	Present access and recreation opportunities may be temporarily limited or closed during construction.	Present access and recreation opportunities may be temporarily limited or closed during construction.
	Long-Term Project Effects	May continue downward trend in loss of natural resources, access, and recreation opportunities.	Improvements to beach access limited to replacement of two dike-top trails. One boat ramp will be removed.	Improved pedestrian access at four sites. One boat ramp removed and one relocated. Adds length to the Olympic Discovery Trail.	One boat ramp at North Fork Skagit River will be removed.
Commercial Fisheries & Aquaculture	Short-Term Construction Effects	N/A	Not likely to affect commercial fisheries or aquaculture during construction.	Not likely to affect commercial fisheries or aquaculture during construction.	Not likely to affect commercial fisheries or aquaculture during construction.
	Long-Term Project Effects	Continued decline of commercial finfish and shellfish populations due to habitat degradation and loss.	Significant benefits to commercial fish and shellfish species by increasing habitat and improving water quality, but less than Alternative 3.	Significant benefits to commercial fish and shellfish species by increasing habitat and improving water quality.	Benefits to commercial fish and shellfish species by increasing habitat and improving water quality, but much less than Alternatives 2 and 3.

Transportation	Short-Term Construction Effects	N/A	Road closures, vehicle traffic re-routing.	Road closures, vehicle traffic rerouting, and 1 railroad bypass.	Fewer road closures, less vehicle traffic re-routing than other Alternatives.
	Long-Term Project Effects	No direct impacts to transportation. Vulnerable infrastructure may experience occasional or prolonged loss of use due to sea level change (e.g., overtopping, flooding).	No change to transportation. Structures would be less vulnerable to sea level change (may be larger or higher roads/bridges).	No change to transportation. Structures would be less vulnerable to sea level change (may be larger or higher roads/bridges). Bridge removal at Harper would add 1 mile to drive around.	No change to transportation. Structures would be less vulnerable to sea level change (may be larger or higher roads/bridges).
Public Safety	Short-Term Construction Effects	N/A	Temporary road detours would adhere to all current safety standards.	Temporary road detours would adhere to all current safety standards.	Temporary road detours would adhere to all current safety standards.
	Long-Term Project Effects	No change to public safety.	Replacement of armoring, utilities, roads, bridges, and levees incidental to the restoration efforts. No loss to public safety.	Replacement of armoring, utilities, roads, bridges, and levees incidental to the restoration efforts. No loss to public safety.	Replacement of armoring, utilities, roads, bridges, and levees incidental to the restoration efforts. No loss to public safety.

5.6 CUMULATIVE EFFECTS OF THE AGENCY PREFERRED ALTERNATIVE

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. This section discusses the analysis of Alternative 4, which was selected as the Agency Preferred Alternative.

5.6.1 Cumulative Effects Analysis Methodology

The cumulative effects analysis incorporates information from a variety of sources. Each proposed restoration site design was examined to evaluate the expected environmental effects. Then records from local entities were reviewed to determine the combined effects expected from restoring sites in each sub-basin. The time scale for analysis of cumulative effects includes projects 10 years past, active projects, and projects planned for the next 10 years. The spatial scale of analysis for each site is its sub-basin. Effects from past, present, and reasonably foreseeable future projects within these sub-basins were quantified by examining records available through the following sources: Washington State Department of Transportation database (WSDOT 2012); Puget Sound Regional Council's Transportation 2040 Plan (PSRC 2010); Lead Entity Habitat Work Schedule Public Portal map with descriptions of completed, active, and proposed restoration projects (WDFW et al. 2012); and the Corps' database of Clean Water Act Section 404 permits issued for restoration projects within tidally influenced areas (USACE 2012b). In addition, the Corps contacted WDFW watershed stewards for their input into the cumulative effects analysis. After analyzing each of these sources, a cumulative effects analysis was compiled for each proposed site in combination with expected effects from other actions in the same sub-basin.

5.6.2 Summary of Past, Present, and Future Actions and Cumulative Effects by Sub-basin

Each of the sub-basins where one or more of the three proposed restoration sites are located was analyzed for cumulative effects based on the temporal and spatial scales described above and analysis results for each sub-basin are summarized in the following sections.

5.6.2.1 *Whidbey Sub-basin*

Negative effects to ecological processes in the Whidbey Sub-basin are a result of past and present diking for agriculture in the Skagit, Stillaguamish, and Snohomish Rivers, and on Whidbey Island, and extensive fill in the Snohomish Estuary due to urbanization in the City of Everett. One of the proposed sites is located in the Whidbey Sub-basin; this is the North Fork Skagit River Delta site.

The Whidbey Sub-basin has many opportunities for restoration since most of the surrounding land use is not residential or commercial development. Most of these restoration efforts are focused around the three major river deltas (Skagit, Stillaguamish, and Snohomish), led by entities such as Snohomish County, Skagit Fisheries Enhancement Group, and TNC. In the past 10 years, there have been 20 completed projects restoring and protecting a variety of shoreline habitats in the Whidbey Sub-basin, including several large-scale restoration efforts like Union Slough and Diking District 6 in the Snohomish River delta, and phase 1 of Deepwater and Fisher Sloughs in the Skagit River delta. There are 18 active restoration actions, including Qwuloolt in the Snohomish River, and 13 similar proposed actions such as McElroy Slough in the Skagit River and Biringer Farms in the Snohomish River Delta. The Lummi Tribe is constructing mitigation bank areas downstream from the proposed project site. This data is current as of 2014.

Skagit County has been considering improving and raising levees and constructing new levees along the lower Skagit River. In the past 10 to 20 years the Corps of Engineers Regulatory Branch has issued roughly 50 Nationwide Permit 13: Bank Stabilization letters of permission and over twice as many Individual Permits (likely associated with development), which are scattered throughout the sub-basin, but many are concentrated in the City of Everett on the Snohomish River, along the Skagit River, and Padilla Bay. In Skagit and Snohomish Counties, WSDOT has 87 completed projects and 34 active projects, many of which are in and around the City of Everett. These projects include widened lanes on SR 20, armoring the Skagit River along SR 20 and SR 530, storm water treatment, creating wetlands, adding large woody debris, and improving fish passage in the Snohomish River delta.

The cumulative effects of multiple restoration actions in these river deltas and the surrounding areas, including those in the preferred alternative, would provide wetland habitat and coastal embayments and help offset the negative impacts of past and ongoing development in the basin. Cumulative effects to ecological and other resources expected within this sub-basin are summarized in Table 5-15.

Table 5-15. Cumulative Effects Expected in the Whidbey Sub-basin

What cumulative effects could occur within the Whidbey Sub-basin from Nearshore Study-identified work combined with other past, present, and future actions?	
Ecological Resources	Although other projects in the sub-basin may occur concurrently with the construction at the site in this sub-basin included in the preferred alternative, work would occur during allowable work periods and low tides to minimize effects of turbidity and noise. The incremental cumulative effects of construction of this site would be temporary. Long-term cumulative effects of multiple restoration actions in this sub-basin would support large populations of salmon, and resident and migratory birds, as well as commercially important shellfish. Since the three rivers in this sub-basin support large runs of salmon, particularly the Skagit, restoration efforts could aid in the recovery of Southern Resident killer whales by supporting their prey.
Socioeconomics	Restoration of tidally influenced marshes may decrease abundance of freshwater waterfowl for hunting and limit access for recreation. Increases in recreational

	fishing could result from the improvements in habitat. There is a growing concern in Snohomish and Skagit Counties over loss of farmland in the highly fertile floodplains and deltas of Skagit, Snohomish, and Stillaguamish Rivers mostly due to development, but also because of restoration. Large-scale restoration efforts in these river deltas, including those in the preferred alternative, may have cumulative effects to croplands. Job opportunities would arise from construction of these restoration sites as well as others in the basin, which may extend to individuals outside of the Whidbey sub-basin.
Transportation	This site would permanently affect one short rural road. Other construction in this sub-basin would likely be concurrent with restoration work and concentrated around the City of Everett, with no potential for cumulative effects associated with the North Fork Skagit River Delta site.
Cultural Resources	The Whidbey sub-basin is extremely rich in archaeological resources and historic built environment. This sub-basin contains some of the earliest and rarest archaeology sites in western Washington. Despite industrial growth and the extensive land modification in this sub-basin due to agriculture and tidal reclamation, the region was used extensively ethnographically, and has a high potential to yield substantive data about early historic interactions with tribal groups and agricultural development.

5.6.2.2 *San Juan Islands/Georgia Strait Sub-basin*

Many areas in the San Juan Islands/Georgia Strait Sub-basin are unchanged from historical conditions, largely due to the dominance of rocky shorelines in the San Juan Islands making alterations difficult. Shoreline alterations are a result of diking in the Nooksack River delta, armoring around the City of Bellingham, and the restriction of coastal embayments by nearshore roads in the San Juan Islands. One of the proposed sites is located in this sub-basin: the Nooksack River Delta near the Canadian border.

In the past 10 years, there have been 19 completed projects restoring habitat in the San Juan Islands/Georgia Strait Sub-basin, with 26 Nationwide 27: Aquatic Habitat Restoration permits issued. These projects include actions in the Nooksack Delta like Smuggler's Slough implemented by the Lummi Nation, salt marsh restoration near the City of Bellingham, and a few small-scale projects in the San Juan Islands implemented by the Friends of the San Juans restoring pocket beaches and embayments. There are nine active restoration and protection actions and five similar proposed actions. The Corps of Engineers Regulatory branch has issued approximately 30 to 40 Nationwide 13: Bank Stabilization permits and 50 to 100 Individual Permits in the last 10 to 20 years in the basin, many of which are concentrated in Anacortes, Bellingham, and harbors in the San Juan Islands. WSDOT completed 25 projects in the last 10 years that involved widening roads and replacing bridges and culverts, including the realignment of a road away from the Nooksack River; another 11 projects are active. No major road improvements with potential effects are planned in the area other than widening Mt. Baker Road and replacing culverts in northern Orcas Island. This data is current as of 2014.

The cumulative effects of large-scale restoration in the Nooksack River and smaller projects in the San Juan Islands would provide wetland habitat and coastal embayments and help offset past and ongoing development in the basin. Cumulative effects to ecological and other resources within this sub-basin are summarized in Table 5-16.

Table 5-16. Cumulative Effects Expected in the San Juan Islands/Strait of Georgia Sub-basin

What cumulative effects could occur within the San Juan Islands/Strait of Georgia Sub-basin from the Nearshore Study-identified work combined with other past, present, and future actions?	
Ecological Resources	Although other projects in the sub-basin may run concurrently with Nooksack, work would occur during allowable work periods and low tides to minimize cumulative effects of turbidity and noise. Large-scale restoration efforts in the Nooksack River delta combined with improvements to embayments and pocket beaches would provide rearing habitat for juvenile salmonids. Kelp and eelgrass beds should improve as sediment and nutrient inputs are restored, which would provide nursery habitat for many fish and invertebrates. Significant improvement in the Nooksack River estuary may aid in the recovery of Chinook salmon, and thus benefit Southern Resident killer whales.
Socioeconomics	Restoration of tidally influenced marshes in the Nooksack may decrease abundance of freshwater waterfowl for hunting and limit access. Increases in recreational fishing could result from the improvements in habitat. Commercial shellfish beds in the Nooksack River delta may be affected by dike removal, but overall would benefit from increased sediment and nutrient delivery and more wetlands that would improve water quality. Job opportunities would arise from construction of restoration sites, which may extend to individuals outside of the San Juan/Strait of Georgia sub-basin.
Transportation	The Nooksack River delta site would require the construction of six new bridges and raising roads. Other construction in this sub-basin may be concurrent with the proposed restoration work, but not likely in the same area. Cumulative effects are possible; however, they would be limited to the duration of construction.
Cultural Resources	Due to the large volume of archaeological sites that would be affected by the proposed restoration work, (known archaeological sites within the Nooksack River Delta) there is potential for significant loss of prehistoric and historic information about this sub-basin. Many of these sites, which have been identified as part of regional studies in the sub-basin, have not been subject to thorough documentation and present an unknown amount of research potential. As restoration activities that include the removal of agricultural or flood control structures may subject resources to degradation through tidal influences, there is potential for a high density of sites from one cultural group to be lost. However, comprehensive data recovery and analysis from these sites may add to a regional understanding of prehistory throughout the sub-basin. Cultural resource losses in the sub-basin are primarily attributable to new commercial and residential construction projects and demolition due to neglect; these activities will continue in the near future. Restoration activities have potential for adverse effects to National Register-eligible archaeological sites and historic buildings and structures located within the Nooksack River Delta. Resolution of adverse effects to National Register-eligible archaeological sites or historic buildings/structures would follow the procedures outlined in the PA.

5.6.2.3 *Hood Canal Sub-basin*

Negative effects to ecological processes in the Hood Canal Sub-basin are a result of nearshore roads such as Highway 101 restricting tidal flow at many of the tributary rivers and small creeks, diking in larger river deltas like Skokomish and Big Quilcene, and extensive armoring in the southern portions. One proposed restoration site is located in this sub-basin: Duckabush River Estuary near the northern end of Hood Canal. Cumulative effects to ecological and other resources within this sub-basin are summarized in Table 5-17.

Table 5-17. Cumulative Effects Expected in the Hood Canal Sub-basin

What cumulative effects could occur in the Hood Canal Sub-basin from Nearshore Study-identified work if combined with other past, present, and future actions?	
Ecological Resources	Although other projects in the sub-basin may be concurrent with construction at the Duckabush River Estuary, work would occur during allowable work periods and low tides to minimize cumulative effects of turbidity and noise. Restoration of wetlands in the larger river deltas and smaller embayments would benefit salmon and birds. Removing tidal barriers would increase sediment and nutrient delivery to eelgrass beds in Hood Canal and provide suitable substrate for forage fish.
Socioeconomics	Restoration efforts that benefit salmon would benefit recreational fishing. Improvements to water quality from increased wetlands would benefit the shellfish industry in Hood Canal. Job opportunities would arise from construction of the Duckabush restoration site as well as others in the basin, which may extend to individuals outside of the Hood Canal Sub-basin.
Transportation	The new bridge construction for replacement of the two bridges at the Duckabush Estuary would cause only short-term closures to Highway 101. Traffic would see minor effects during construction. No other WSDOT projects are planned in the area, so there would be little to no cumulative effects.
Cultural Resources	While limited archaeological surveys have been completed around the proposed site, shorelines of the Hood Canal sub-basin contain a variety of prehistoric shell middens, lithic scatters, and burial sites, as well as historic logging and homesteading sites. While development has been limited around Hood Canal, transportation projects, such as Highway 101, have impacted traditional tribal lands and archaeological sites. If sites are found within this area, their disturbance would contribute to an ongoing loss of prehistoric and historic data about the region. Losses of historic properties in the sub-basin are primarily attributable to new rural residential construction, demolition due to neglect, and highway modernization projects; these activities will continue in the near future. Over the 50-year analysis period for the project, bridges would likely be modernized or replaced with or without the project. Restoration activities at Duckabush would have an adverse effect to the National Register-listed Duckabush Bridge. In addition, there is potential for adverse effects to cultural resources that are currently unknown in the Duckabush River Estuary site. Resolution of adverse effects to National Register-eligible archaeological sites or historic buildings/structures including the National Register-listed Duckabush Bridge would follow the procedures outlined in the PA.

In the past 10 years, there have been 44 completed projects restoring and protecting a variety of habitats in Hood Canal with 31 Nationwide 27: Aquatic Habitat Restoration permits issued.

There are 16 active restoration projects and 22 proposed. These projects include dike removal in larger deltas like the Big Quilcene and Skokomish Rivers, and culvert replacement in several small streams that empty into Hood Canal. The Hood Canal Salmon Recovery Group is responsible for implementing many of these projects. In addition, the USACE has proposed a large-scale project to restore the Skokomish River. The project focuses on restoring year-round fish passage, increasing habitat complexity and quantity, wetland restoration, and reconnecting off-channel aquatic habitats.

The Corps of Engineers Regulatory branch has issued approximately 50 Nationwide 13: Bank Stabilization permits and an equal amount of Individual Permits in the last 10 to 20 years in the Hood Canal basin, many of which are along the shoreline of Hood Canal. No major road improvements with potential effects are planned in the area. WSDOT has completed 24 projects in Kitsap and Jefferson Counties, such as repairing the Hood Canal Bridge, removing creosote dolphins, upgrading culverts to fish friendly structures, and adding truck lanes. No such projects are proposed to occur near the proposed restoration site in the near future. This data is current as of 2014.

5.6.3 Summary of Direct and Indirect Effects with Synergistic and Countervailing Interactions

Interactive effects may be additive, countervailing, or synergistic (the net cumulative effect is greater than the sum of the individual effects).

Ecological Resources – Negative effects during construction would only endure for brief periods and would vary depending on the resource. Benefits of restoration activities would be countervailing to the construction effects, and the cumulative benefits of restoration along with other restoration actions described in the analysis above would be additive around Puget Sound.

Socioeconomics – Negative cumulative effects include loss of a small dock/marina with the associated decrease in revenue, potential decrease in area or relocation of area where waterfowl hunting is accessible on foot, and potential decrease in area available for shellfish growing pending further analysis at the Nooksack River Delta site. Across all Nearshore Study-identified restoration sites, in conjunction with other restoration actions around Puget Sound, total shellfish growing areas are expected to have a net increase. Other cumulative benefits include improved resiliency and adaptation to SLC across various nearshore habitat types as well as the replaced infrastructure – a pro-active investment that may preclude more expensive emergency reactions. In addition, the restoration sites are expected to provide additional habitat capacity for juvenile salmon rearing, which may increase fish populations and therefore sport and tribal fishing opportunities.

Transportation – Some traffic disruptions and temporary detours could increase commute times for residents at the affected localities during construction. The overall improved traffic flow at

each site involving roadwork is expected to be a countervailing effect to the temporary traffic disruptions. Other cumulative benefits of multiple sites would include reduced susceptibility to road closures due to flooding, and early adaptation to anticipated sea level change.

Cultural Resources – The proposed restoration sites have varying degrees of probability for encountering buried, undocumented artifacts. If such cultural resources are encountered at multiple sites, this would constitute a cumulative effect of disturbance to multiple resources around Puget Sound. Restoration of tidal influences has the indirect effect of continuing the erosion of certain archaeological sites, especially those periodically exposed and subject to wave and wind erosion such as shell middens. Artifacts from sites may erode from their original contexts, lose scientific value, or be exposed for incidental collecting by beach visitors. Mitigation measures for these impacts would be assessed on a site-specific basis and may include archaeological data recovery and site avoidance. However, the loss of valuable cultural resources associated with archaeological sites cannot be entirely mitigated.

Potential for cumulative effects to the historic-age built environment around Puget Sound ranges from low to high depending on sub-basin. The three proposed sites have structures related to historic-age industrial and waterfront-related resources, historic agricultural landscapes including dikes and farmstead buildings and structures, and Highway 101 with historic bridges. The Puget Sound region has been experiencing significant losses attributable to urban sprawl, modernizing and industrial development projects, demolition due to neglect, new commercial and residential construction, and railroad and highway modernization projects.

5.6.4 Cumulative Effects Comparison of Alternatives

The No-Action Alternative has no cumulative effects associated with restoring nearshore landforms; however, it can be inferred that the continued lack of functioning nearshore processes is having the cumulative effect of overall degraded ecosystem functions in Puget Sound. The trajectory for this effect is a continued decline of ecological resources, which influences socioeconomics and recreation quality throughout the region. Alternative 3 would add more acreage of wetlands and remove more linear feet of stressors than Alternatives 2 and 4. Therefore, Alternative 3, combined within other previous and ongoing restoration efforts in the Puget Sound, has potential for greater positive cumulative effects to ecological resources. Positive cumulative effects on socioeconomics of Alternative 3 are greater than Alternatives 2 and 4 due to the improvements in habitat for many commercially valuable species; however, Alternative 3 has potential for greater negative cumulative effects to agricultural lands. Negative cumulative effects to transportation are greater in Alternative 3 due to the temporary closure of more roads; however, the overall benefits of road and bridge updates and improvements are assumed to outweigh the minor effect of temporary road closures. Alternative 3 has far more restoration sites than Alternatives 2 and 4 with certain removal of historic-age structures and likelihood of encountering cultural resources during site restoration activities. All appropriate mitigation would be conducted; however, some loss is anticipated. Alternative 3 is the

environmentally preferred alternative due to having the greatest benefits for ecosystem function; however, Alternative 4 is selected as the agency preferred alternative as part of the implementation master plan described in section 4.3.

5.7 MITIGATION MEASURES*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

NEPA regulations at 40 CFR 1500.2(f) state that Federal agencies shall, to the fullest extent possible, use all practicable means consistent with the requirements of the Act and other essential considerations of national policy to restore and enhance the quality of the human environment, and avoid or minimize any possible adverse effects of their actions on the quality of the human environment. Furthermore, at 40 CFR 1508.20, NEPA defines mitigation to include avoiding impacts by not taking an action, minimizing the magnitude, rectifying the impact through restoring the resource, reducing the impact over the life of the action, or compensating for the impact. Agencies are required to identify and include in the action all relevant and reasonable mitigation measures that could reduce negative effects of the action.

Site restoration would involve construction in proximity to ecological resources. Each site would have short-term construction-related effects with varying spatial and temporal scales and degrees of intensity. Construction designs would include practices that avoid and minimize effects to significant resources.

5.7.1 Standard Practices to Mitigate Negative Effects of Construction

Specific measurable and enforceable mitigation measures will be developed for each site based on its specific impacts. Construction designs and timing would include standard measures:

- In-water work would occur during designated periods consistent with recommended periods established by WDFW and approved by NMFS and USFWS.
- The Corps would schedule work outside of bird nesting season except where unavoidable.
- Each construction site would have an approved Environmental Protection Plan.
- Traffic alterations would be designed to minimize impediments, with the shortest and least disruptive detours possible, and in coordination with the relevant transportation agency(s).
- Bridge reconstruction would provide adequate clearances for navigation of recreational boats on navigable rivers to the extent practicable.

5.7.2 Best Management Practices to Protect Water Quality

Restoration sites in the nearshore zone would involve, by necessity, some in-water work and significant areas of ground clearing. Protecting water quality from storm water runoff would require implementation of best management practices (BMPs) to avoid excessive runoff and elevated turbidity in the receiving water body. As completed sites evolve, they would contribute sediments to the nearshore zone by design; however, it is important to avoid excessive pulses of

sediment during the construction phase that are more than what the surrounding biota can easily tolerate. Every site would have a Storm water Pollution Prevention Plan, Temporary Erosion and Sedimentation Control Plan, and Diversion and Care of Water Plan approved by a Corps staff biologist. Construction contractors would be required to obtain a Construction Storm water Permit under Section 402 of the Clean Water Act. Standard construction storm water BMPs can be incorporated into site designs, operational procedures, and physical measures on site. The following are some examples of frequently used BMPs:

- Minimize area of ground disturbance and vegetation clearing.
- Use the site's natural contours to minimize run-off and erosion.
- Do not expose the entire site at one time; avoid bare soils during rainy months.
- Stabilize erodible surfaces with mulch, compost, seeding, or sod.
- Use features such as silt fences, gravel filter berms, silt dikes, check dams, and gravel bags for interception and dissipation of turbid runoff water.

5.7.3 Mitigation Measures for Effects of Greenhouse Gas Emissions

There are no legal requirements to mitigate for GHG emissions; however, BMPs are available for fuel and material conservation during construction. Such BMPs include the following:

- Maximizing use of construction materials that are reused or that have a high percentage of recycled material content, such as recycled asphalt pavement, concrete, and steel.
- Obtaining construction materials and equipment from local producers or vendors to minimize energy use for shipping.
- Encouraging construction personnel to carpool or use a crew shuttle van.
- Turning off equipment when not in use to reduce idling.
- Maintaining equipment in good working order to maximize fuel efficiency.
- Routing truck traffic through areas where the number of stops and delays would be minimized, and using off-peak travel times to maximize fuel efficiency.
- Scheduling construction activities during daytime hours or during summer months when daylight hours are the longest to minimize the need for artificial light.
- Implementing emission-control technologies for construction equipment.
- Using ultra low sulfur (for air quality) and biodiesel fuels in construction equipment.
- Using warm mix asphalt or cool pavement rather than hot mix asphalt.
- Using renewable energy produced onsite or offsite. For example, using solar-powered generators to supply electricity for field offices and construction lighting.

5.7.4 Mitigation Measures for Underwater Noise Effects

As described in section 5.1.8, certain project sites would have noise-producing activities that have potential for adverse effects to aquatic species. Construction methods would incorporate as many mitigation measures as feasible to reduce noise effects to below harmful thresholds. Pile drivers can use shielding and dampening methods and materials at the point of impact; bubble

curtains use controlled, specially sized air bubbles to dampen the sound pressure waves to minimize effects on aquatic life. Additionally, sound-absorptive mats called sound aprons made of rubber, lead-filled fabric, or plastic layers can be hung around the noise source to help shield the aquatic environment from excessive noise. Construction timing can avoid exposure of animals to sound by observing designated periods to schedule the noise-inducing activities for times when the animals are not likely present, and by limiting work to low tides to take advantage of the way shallow water attenuates low frequencies and to reduce the area of effect. Marine mammal and bird monitoring plans can be implemented to alert construction teams when the animals are nearby and work should stop until the animals leave.

5.7.5 Best Management Practices and Mitigation Measures for Cultural Resources

The Corps will consult with the SHPO, ACHP, and federally recognized Native American Tribes on appropriate mitigation measures following the procedures laid out in the PA. Specific plans for BMPs for cultural resources are listed below:

- Update Historic Context for Levee Systems
- Identification of Area of Potential Effect (APE)
- Identification and Evaluation of Historic Properties:
  - Updated Literature Review/Background Research
  - Archaeological Survey and Testing
  - Historic Age Buildings and Structures Inventory
  - Traditional Cultural Property Inventory

If any cultural resources identified within the APE are eligible for the National Register, the Corps will make effects assessments. Should the proposal have an adverse effect on an eligible cultural resource that cannot be avoided, the Corps would work toward a resolution of adverse effects with the SHPO/ACHP, tribes, and other consulting parties following the procedures laid out in the PA. Examples of mitigation measures include but are not limited to the following:

- Recordation packages using digital photography and 35 mm black-and-white film photography
- Treatment Plans
- Public Interpretation
  - Museum/Traveling exhibits
  - Public talks
  - Educational material prepared for local schools
  - Interactive websites
- Oral History Documentation
- Historic Property Inventory
- Geo-Referenced Historical Maps and Aerial Photographs

6 RECOMMENDED PLAN

Based on the results of over 10 years of analysis by the Nearshore Study, the Corps is proposing a suite of ecosystem restoration sites throughout the Puget Sound that address degradation of the nearshore zone. The comprehensive restoration strategy for Puget Sound identified a total of 36 sites for restoration. Of those 36 sites, three are recommended for construction authorization under this Corps feasibility study and are presented as the recommended plan in this chapter. In addition to these three sites, nine sites are recommended for additional study under the Corps general investigations program. These sites are discussed further in Appendix K.

The implementation strategy allows for the three sites to move forward now because they provide key restoration across three separate areas of the Puget Sound. The additional nine sites recommended for further study ensure a watershed level solution for the most complex, large-scale restoration projects identified as critical for restoring the Puget Sound. Finally, the other 24 sites identified as part of the 36 site master implementation plan are being carried out under other Corps authorities or through non-federal actions and are complementary to achieving the overall study objectives. These can be completed concurrently with the implementation of sites recommended through the General Investigation study process.

The recommended plan includes three sites that, taken together, restore 2,101 acres of tidally influenced wetlands and would remove 28,860 linear feet of stressors from the nearshore zone, restoring the natural processes that support VECs and promoting the ecosystem structures and functions provided by wetlands, kelp and eelgrass beds, and riparian vegetation. Sites included in the recommended plan have costs ranging from $91 million to $262 million per site, with an estimated total project first cost of approximately $451.6 million (March 2016 price level). There are no costs or features (local betterments) that have been identified for implementation.

Please reference section 6.1 and Appendix B (Engineering) for detailed information regarding the three sites in the recommended plan. A map of the three sites included in the recommended plan is presented in Figure 6-1.

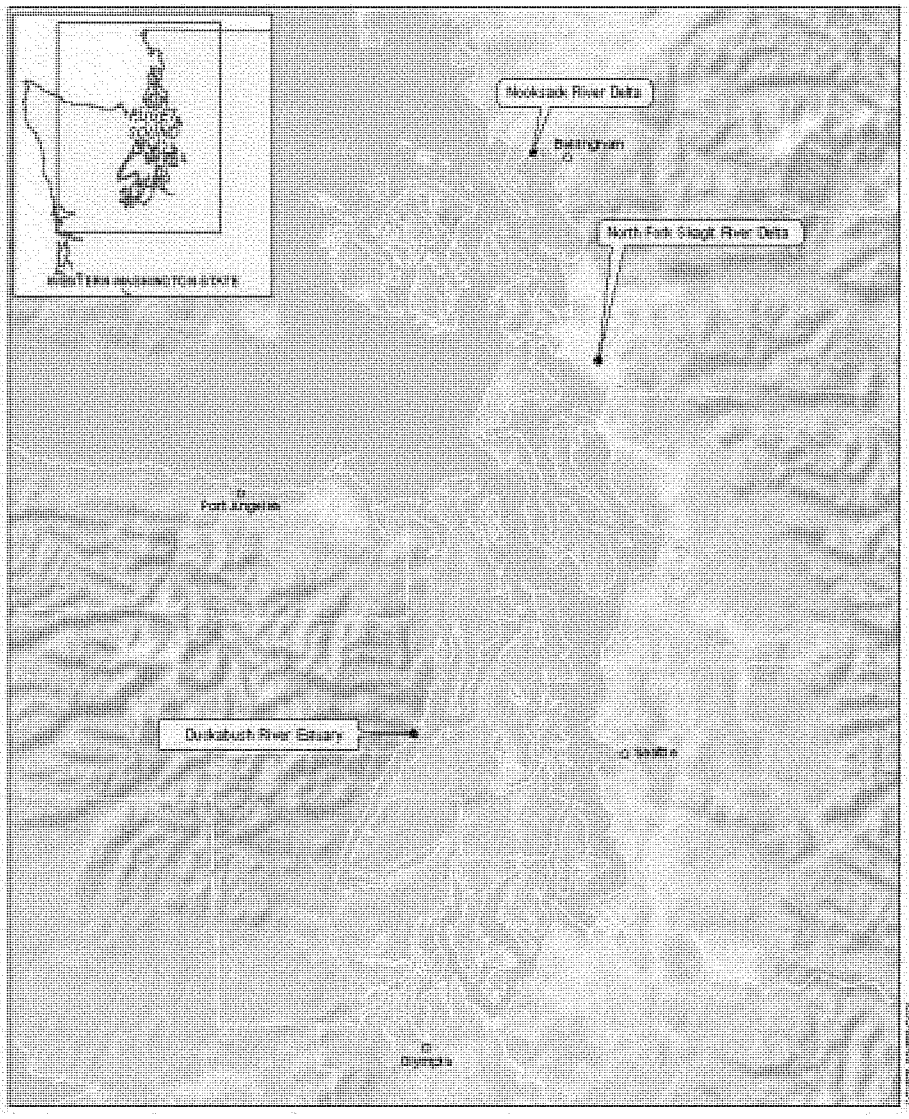


Figure 6-1. Geographic Locations of the Sites included in the Recommended Plan

6.1 SITES INCLUDED IN THE RECOMMENDED PLAN

The following sections provide additional information about each of the three sites of the recommended plan. Specific design details about each site can be found in Appendix B (Engineering Appendix).

6.1.1 Duckabush River Estuary

6.1.1.1 *Site Description, Geographic Location & Context*

The Duckabush River is one of several major river systems that drain the east slope of the Olympic Mountains to Hood Canal. The broad river delta fans out into Hood Canal on the south side of the Black Point Peninsula at approximately Mile 310 of Highway 101 (Figure 6-2). The estuary contains salt marshes, eelgrass beds, and extensive mud and gravel flats that support productive shellfish beds. The Duckabush Estuary is also home to harbor seals, bald eagles, and regionally significant winter waterfowl.

The Duckabush River is contained within a single channel through the site before emptying into the marsh and submerged marsh outboard of the site. The historical northern arm of the river has been blocked, is aggraded, and is now a partially filled dead-end tidal channel in the middle portion of the site. The Duckabush River Estuary was bisected by an early roadway and bridge that spanned the two distributary channels. A portion of the roadway, dikes, and abutments remain in place today. The majority of this infrastructure was removed and replaced in 1934 with two separate bridges as part of the construction of Highway 101. This highway cuts across the intertidal river delta and estuary wetland complex, spanning the main channel and a former distributary channel via two bridges. The Highway 101 bridges impact the Duckabush estuary, disrupting tidal circulation and impeding fish access to productive salt marsh and slough habitats (WDFW and PNPTT 2000). These hydrologic constrictions along with fill within the estuary have led to decline in mudflats and salt marshes. In addition, training berms are in place at the southern distributary arm of the Duckabush River, just upstream of the Highway 101 crossing, to control lateral movement of the channel and prevent river flows into the historical distributary channels. These berms severely restrict lateral connectivity with tidal channels and salt marsh habitat (Correa 2003).

The Duckabush Estuary is home to trumpeter swans, bald eagles, and regionally significant winter waterfowl. Harbor seals haul out in this location throughout the year and pupping occurs in the winter. The extensive mud and gravel flats are productive shellfish beds. Salt marshes and eelgrass beds characterize the upper and lower intertidal and subtidal areas, respectively. Herring use this eelgrass for spawning. The Duckabush River hosts four ESA-listed species of salmon: Hood Canal summer chum, Puget Sound steelhead, Coastal/Puget Sound bull trout, and Puget Sound Chinook salmon. The wild Chinook run is nearly extirpated from this river.

The proposed restoration would restore tidal and riverine hydrology to 38 acres of the Duckabush River Delta. This action would allow for natural habitat forming processes including sediment and detritus exchange, tidal channel formation, freshwater input, and tidal flushing within the delta.

6.1.1.2 *Site-Specific Goals & Objectives*

The goal of this project includes restoration of tidal exchange and re-establishment of distributary channels to improve connectivity in the Duckabush River Estuary. The following are the site-specific objectives for the Duckabush River Estuary, and all are applicable for the 50-year period of analysis:

- Reconnect and restore lost tidally influenced areas including estuarine and freshwater tidal wetlands in the Duckabush River Estuary.
- Re-establish distributary channels in the Duckabush River Estuary to promote greater diversity of delta wetland habitats.
- Restore mudflats and salt marsh in the Duckabush River Estuary.

6.1.1.3 *Site-Specific Constraints*

The following are notable issues that could constrain the plan formulation:

- The project cannot adversely affect the use of Highway 101 as the primary north-south access corridor for the Olympic Peninsula in Washington State.
- The Duckabush Bridge is listed on the National Register. Effects to this bridge will be evaluated and actions to avoid or mitigate potential impacts will be identified.
- The Skokomish Indian Tribe is a federally recognized tribal nation that has treaty-reserved fishing, hunting, and gathering rights in the project area; negative effects to tribal interests will be avoided to the maximum extent practical.

6.1.1.4 *Initial Plan Formulation*

Previously existing plans for this restoration site were considered during the Study Team's initial plan formulation process. Elements found in the Hood Canal Coordinating Council's 2004 publication titled, Salmon Habitat Recovery Strategy for the Hood Canal & Eastern Strait of Juan de Fuca" as well as their "2005 Hood Canal & Eastern Strait of Juan de Fuca Summer Chum Recovery Plan" are included in the Nearshore Study design alternative. While the prior plans' goals and objectives were focused on the recovery of a single species of salmon, the plans dovetailed very well into the Nearshore Study's goals and objectives to provide a holistic restoration of substantial areas of aquatic nearshore habitats. The Corps used aspects of these plans as a starting point for initial plan formulation activities.

As described in section 4.1, a suite of 21 different management measures were identified for implementation across Puget Sound. Management measures identified for this study are fully

outlined in the Management Measures for Protecting and Restoring Puget Sound Nearshore (Management Measures Technical Report, Clancy et al. 2009). Structural measures (e.g., armor removal, dike removal, channel rehabilitation, etc.) and non-structural measures (invasive species control, physical exclusion, public education, etc.) were identified and evaluated. A summary of the 21 management measures and their relationships to nearshore ecosystem processes are shown in Table 4-1. As described in section 4.1, the 21 management measures were classified into three groups: restorative measures, prerequisite measures, and protective measures. Of the 21 management measures originally identified, nine management measures were carried forward in the formulation of alternative plans. Seven of the nine measures are classified as restorative measures, which exert long-lasting effects on ecosystem processes and will often provide the best opportunity of achieving complete restoration of processes, directly meeting the planning objectives of this study. In addition to these nine restorative measures carried forward.

Based on the screening described in section 4.1, the study team evaluated which of the nine remaining management measures could be implemented at the Duckabush River Estuary site. The team qualitatively determined whether the identified measures met the site-specific planning objectives and generally avoided site-specific planning constraints. The following five management measures were carried forward for evaluation at this site:

- Remove, modify, or realign the Highway 101 causeway to restore the tidal prism of the delta as well as reconnect freshwater and tidal flows to remnant distributary, tidally influenced channels, and tributary wetlands
- Remove fill (training berms) from the Duckabush River upstream of Highway 101 and adjacent areas to reconnect the river to its intertidal floodplain and wetlands, restore floodplain and estuary wetland processes, and increase channel density
- Reestablish tidally influenced distributary channels, replace a culvert at Shorewood Road with a bridge, and excavate channels within the marsh areas to restore tidal channel formation, exchange of aquatic organisms, and sediment accretion and erosion for greater habitat diversity, which increases biodiversity
- Large wood placement for channel stability, which will increase habitat complexity
- Riparian revegetation for shading, nutrient inputs, and complexity of bank habitat (non-structural measure)

The primary measure for this site is hydraulic modification associated with the Highway 101 causeway and two bridges spanning the estuary, as these structures are the key impediment to restoration at the site. Early plan formulation activities were driven by two key planning constraints outlined above: maintain the Highway 101 transportation corridor and evaluate effects to the Duckabush Bridge (NRHP listed). These key constraints guided the plan formulation process for this site and led the team to identify four bridge removal or realignment options:

1. **Complete removal and realignment of the Highway 101 causeway and bridges.** This plan includes full removal of the Highway 101 causeway and bridges across the estuary. An elevated roadway on a 2,100-foot-long bridge would be constructed in a new alignment further upstream from the existing highway, allowing the greatest extent of tidal exchange in the estuary as well as allowing natural meandering of the channel for dynamic habitat creation.

2. **Limited removal and realignment of the Highway 101 causeway and bridges.** This plan would retain the present roadway on the south end of the Duckabush Bridge and dead-end the roadway at the Duckabush Bridge. A new road and causeway would be constructed to the east to maintain the Highway 101 transportation corridor. This plan was not recommended because it would fail to achieve a substantial portion of the ecosystem objectives at this site by keeping the main channel locked in place without possibility for natural meandering important for dynamic habitat creation. In addition, this plan would leave in place one of the primary stressors identified as a problem at this site (Duckabush Bridge).

3. **Retain Duckabush Bridge and Elevate Causeway.** This plan would retain the existing Duckabush Bridge superstructure and elevate it onto a causeway in its existing alignment. This plan is not recommended because it would fail to achieve a majority of the ecosystem objectives at this site by preventing process-based restoration and would not improve ecosystem functions due to failure to remove the primary stressors identified as a problem at this site.

4. **Retain Duckabush Bridge and Relocate Causeway.** This plan would remove the roadway on both ends of the Duckabush Bridge but keep the bridge in place. A pedestrian access boardwalk would be constructed to allow visitor access to the historic bridge. A new roadway would be constructed to the east to maintain the Highway 101 transportation corridor. This plan is not recommended because it would not achieve a substantial portion of the ecosystem objectives at this site by keeping the main channel locked in place without possibility for natural meandering and leaves in place one of the primary stressors identified as a problem at this site. The boardwalk would shade an area that should otherwise support tidal wetlands, and the required parking area would forego the need for a vegetated wetland buffer area to protect the investment in restoration at the site. Finally, additional revetment/scour protection measure for the bridge footings would likely be required, and there is a high possibility that the boardwalk would have to be moved, repaired, or reconstructed to account for dynamic river processes.

Plan #1 (Complete removal and realignment of the Highway 101 causeway and bridges) was carried forward because it meets the study objectives, avoids constraints, and restores critical habitat for nationally significant resources. Removal and realignment of the causeway will allow

tidal exchange to the entire estuary, allow the channel to dynamically evolve over time, and restore freshwater input as well as sediment transport.

6.1.1.5 *Summary of Proposed Action*

The restoration proposal would include the removal of the Highway 101 causeway and bridges across the estuary, allowing significant restoration of tidal exchange in the Duckabush River Estuary. An elevated roadway on a 2,100-foot-long bridge would be constructed in a new alignment further upstream from the existing highway, allowing for tidal exchange to occur and distributary channels to develop while maintaining the key transportation route on Highway 101. Berms along the river would be removed to restore channel migration and channels would be excavated at or near their historical configurations, which would reestablish tidal and freshwater connections throughout the estuary. The bridge span of 2,100 feet, discussed in Engineering Appendix Section 1-6.1.1, is the result of feasibility level engineering of the conceptual design to accommodate modern design standards for the highway and result in no new areas of fill in the estuary. Figure 6-2 depicts the key design elements at the Duckabush River Estuary.

6.1.1.6 *Hydrology & Hydraulics*

Flood Limits: The Duckabush River Estuary is confined within steep valley walls. High tides fill the estuary from one side to the other at Highway 101. The primary source of flooding in the vicinity of the site comes from coastal storm surge associated with low pressure and large storms on the Pacific side of the Olympic Peninsula. The 1% Annual Exceedance Probability (AEP) coastal base flood elevation indicates a static rise of about 6.5 feet above the highest high tide level. The replacement of the causeway at Duckabush with an elevated bridge will not affect coastal flood elevations. The bridge removal will potentially reduce backwater and flooding associated with high flows on the Duckabush River.

Modeling: Flood elevations for the Duckabush site were taken from the Federal Emergency Management Act (FEMA, 1982) Flood Insurance Study for Jefferson County. In addition, both USACE (2003) and USBR (2004) both conducted channel migration zone studies on the Duckabush River at and above the estuary and this information was used to confirm the expected width of the active channel after bridge and road embankment replacement. In PED, survey information along with a tidal hydraulics analysis will be used to model the flows in the estuary and confirm the expected area of benefits from the causeway removal. The Base Flood Elevation from coastal flooding will be verified to inform the design of the final bridge and roadway elevation. River modeling and sedimentation analysis is needed to ensure no adverse effects of the increased conveyance downstream on upper reaches of the Duckabush River as well as to predict the evolution of the restored distributary channels and their effect on the estuary.

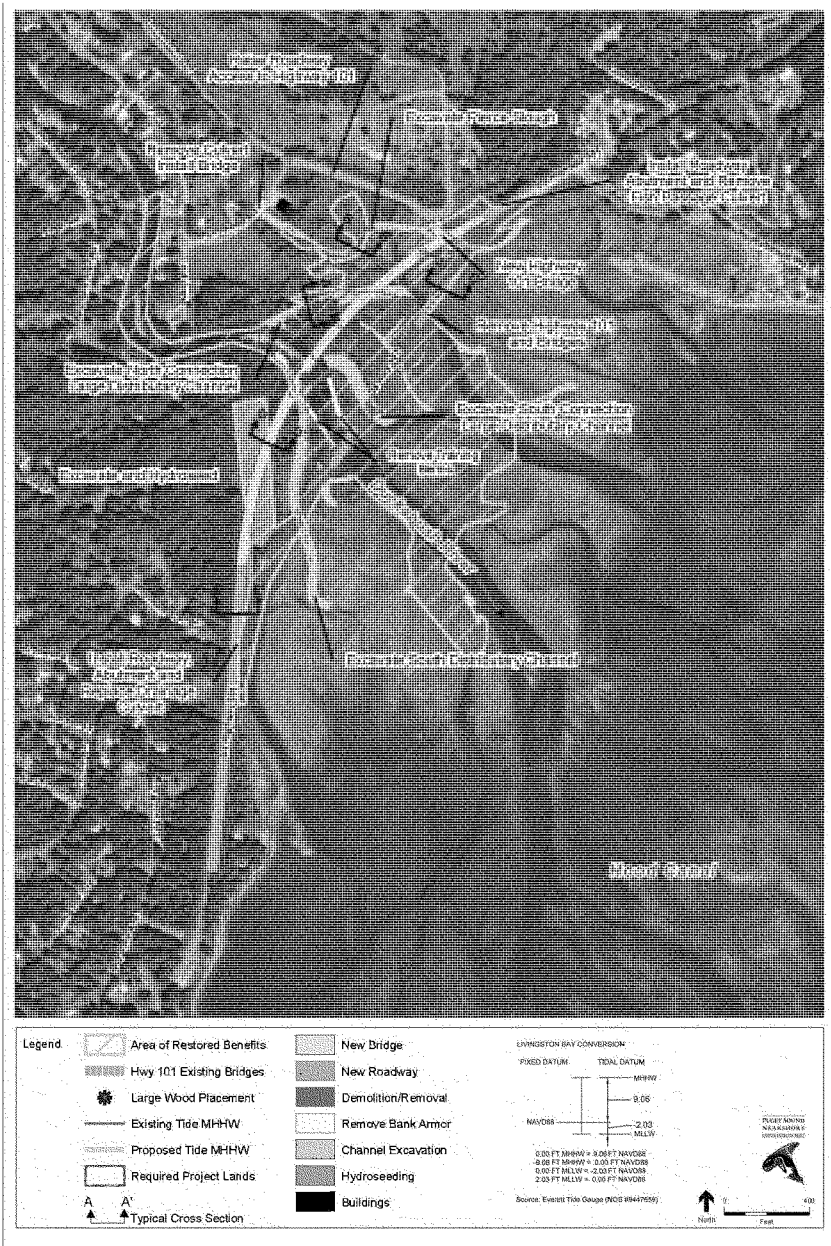


Figure 6-2. Duckabush River Estuary

6.1.1.7 *Operations & Maintenance*

Operations and maintenance costs for the Duckabush restoration are related to maintenance and repair of the new bridge, roadway, and roadway embankment. Additional OMRR&R activities may include actions such as removal of invasive plant species, debris and sediment removal to maintain tidal flow to the north distributary channel, and maintenance of culverts including removal of debris and sediment. The annual OMRR&R estimate is approximately $122,000 per year; OMRR&R activities are a non-Federal sponsor responsibility.

6.1.1.8 *Public Review*

There were no specific comments related to Duckabush during public review of the Draft FR/EIS. The Corps and non-Federal sponsor will continue to coordinate with landowners and stakeholders as the study progresses.

6.1.1.9 *Risk & Uncertainty*

The study team has used a risk-based strategy in their approach to formulating the project from the early stages of the study. Key risks or uncertainties associated with this site include the following, along with the strategy to reduce risk as the study continues.

Earthwork Quantities

Risk and Cause: Earthwork quantities were determined based on available LiDAR data. In addition, no soil investigations have been done on site to characterize possible settlement of the project features.
Risk Management: Additional survey data, LiDAR and soils information will be obtained during the PED phase. Additional hydraulic modeling and geotechnical analysis will be conducted to refine the size and scale of roadway embankments. PED costs include estimates for obtaining the required data and performing necessary engineering analyses. The Cost Schedule Risk Analysis (CSRA) for the project has identified risks associated with the variability in existing survey/ LiDAR data with varying resolution as well as uncertainty in future settlement of roadway embankments. Cost contingencies reflect the uncertainty in quantities of material required for construction.

Bridges & Roads: Foundation and Placement

Risk & Cause: The bridge and foundation geometry are likely to change based on design to occur in PED. Some elements of the scope of the proposed bridge may be adjusted based on additional analysis and design (e.g., longer spans, larger piers, or raising the bridge).
Risk Management: Additional survey data, LiDAR and soils information will be obtained during the PED phase. Additional hydraulic modeling and geotechnical analysis will be conducted to refine the size, scale, and alignment of the new bridge. PED costs include estimates for both obtaining the required data and performing necessary engineering

analyses. Cost contingencies reflect the uncertainty in quantities of material required for construction.

Duckabush Bridge Removal

Risk & Cause: The Duckabush Bridge is listed on the NRHP and is proposed for removal as part of the recommended plan.
Risk Management: Section 106 coordination and consultation for an agreement document (i.e., a PA) is complete. If it is determined that the project will have an adverse effect on any significant structures, the Corps will avoid, minimize, or mitigate following Section 106 procedures and stipulations in the PA. Effects to the Duckabush Bridge will be evaluated and actions to avoid or mitigate potential impacts will be confirmed during PED. The current cost estimate assumes $500,000 for mitigation associated with the Duckabush Bridge removal. The cost estimate also assumes complete removal of the bridge; it is assumed the existing structure will not be relocated intact to another location. Cost contingencies reflect the potential for mitigation costs higher than currently estimated.

6.1.1.10 *Ecosystem Restoration Benefits*

As Figure 6-2 depicts, this site restores several processes including sediment transport, freshwater input, tidal exchange, distributary channel migration, and marsh accretion. Restoration of this site provides benefits to ESA critical habitat for Chinook salmon, Hood Canal summer chum, steelhead, and bull trout as well as direct benefits to harbor seals, bald eagles, waterfowl, shellfish, and the highly valuable eelgrass habitat at the edge of the site. This project provides an opportunity to reconnect floodplain and intertidal wetlands, improving tidal exchange, sediment transport, and estuary development. Realignment of roads and bridges will restore tidal inundation and hydrology, and reconnection of distributary channels to promote greater diversity of delta wetland habitats. Additional benefits include the following:

- Reconnects and restores 38 acres of scarce tidal marsh and estuarine mixing zone by removing 1,270 linear feet of tidal barrier, roadway, and shoreline armoring, allowing unrestricted flow of freshwater into the estuary (meets site-specific planning objective #1)
- Restores distributary channels, allowing formation of a tidal channel network and more natural tidal exchange for improved estuarine habitat that supports many fish, bird, and invertebrate species (meets site-specific planning objective #2).
- Restores mudflats that benefit native shellfish harvested on the public tidelands and the shorebirds that feed on mudflat invertebrates, as well as salt marsh habitat that benefits waterfowl, shrimp, crab, and salmon (meets site-specific planning objective #3).
- Restores large river delta that provides valuable nursery habitat for juvenile salmon species, increasing survival and supporting Puget Sound population recovery.

6.1.1.11 *Significance*

- Addresses habitat constraints in Hood Canal, which is a partially isolated geographic section of Puget Sound
- Restores intertidal and shallow sub tidal areas that are habitat for recreationally and culturally important shellfish such as oysters, mussels, and clams
- Supports Summer Chum Salmon Conservation Initiative to recover this ESA-listed species
- Supports Puget Sound Chinook Salmon Recovery Plan to recover this ESA-listed species

6.1.1.12 *Site-Specific Environmental Impacts*

Removal of 1,270 feet of tidal barrier and restoration of 38-acre tidal wetlands will achieve long-term benefits in the previous section (*Ecosystem Restoration Benefits*), but will also have short-term construction impacts listed below that are necessary to achieve the benefits.

Physical Environment: Nearshore Processes and Structure

Processes, Physiographic Characteristics, Oceanography, and Sedimentation and Erosion: These resources would all be positively effected as described in the previous section (*Ecosystem Restoration Benefits*) primarily by providing unrestricted tidal flow to the estuary.

HTRW: A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.* This assessment has shown no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites that have the potential to affect work at the project site. Please refer to Appendix B (Engineering) for the complete Phase 1 assessment.

Water Quality: Water quality would experience pulses of turbidity during removal of the Highway 101 bridges and fill across the estuary for the new wide-span bridge piers and culverts; however all work would be done using best management practices during construction of the new bridge including isolation devices such as cofferdams or equivalent, silt curtains, and timing work during low tides to prevent turbidity from affecting the aquatic environment. Installation of water isolation devices may cause pulses of turbidity, but the duration of effect would only be a matter of hours and for an area not likely to exceed an estimate of 600 feet based on velocity of flow in the estuary. Long-term water quality would improve by allowing unrestricted tidal flushing of the estuary and greater freshwater flow into the adjacent nearshore environment.

Greenhouse Gases: Construction machinery was estimated to have GHG emissions of 1,769 tons of CO_2 based on types of machinery that would be used and estimated duration of construction.

Underwater Noise: Machinery would cause underwater noise in the estuary during bridge removal and reconstruction from drilling, and cast-in-place work for pier installation and potential for vibratory pile driving for pile removal if needed. These impacts would be limited to the duration of construction and minimized by working during low tides and low flows. If work occurs from a platform on top of estuary substrate, this would further minimize noise effects.

Biological Environment: Nearshore Functions

Vegetation: Effects to riparian vegetation would be minimized by using temporary access routes via the existing system of county and farm access roads. Staging areas would be determined during the PED phase. Areas free of trees and other native vegetation would be utilized to the extent practicable. Some areas would need to be cleared during construction, such as areas along the installation of the new HWY 101 Bridge, excavation of the North Channel connection to the mainstem of the Duckabush River, and an area of the new Duckabush Road. The number and sizes of trees felled will be determined during PED phase. Replanting of disturbed areas would occur following construction. Eelgrass and patches of brown kelp grow downstream from the project site. Turbidity generated from construction would not be substantial enough to harm this aquatic vegetation given its proximity to the project and the BMPs that would be used.

Shellfish: Shellfish populations are downstream from the project footprint; short-term and long-term effects of sediment to shellfish habitat at the Duckabush estuary will be minimized through design and the implementation of BMPs. For other macroinvertebrates within the project site, actions would have the short-term impact of disrupting or destroying benthic and epibenthic invertebrates. Once the stressors are gone, invertebrate colonization would follow a pattern of succession, with near complete recovery in one to three years (Hueckel and Buckley 1987, Martin 2012 pers. comm.).

Fishes: This estuary hosts herring spawning beaches and serves as a migration corridor for multiple species of salmonids. Negative effects would come from construction activities causing 1) increases in turbidity from excavation of fill, and 2) noise and vibration associated with large equipment operation for excavation and demolition. Elevated levels of turbidity could cause physiological damage to gills, and elevated noise could cause a behavioral response to flee or delay migration. Working within designated in-water work window periods of 16 July to 31 August when fish are less likely to be present and during low tides would minimize effects of noise and turbidity on fish.

Birds: This area has a great blue heron colony, osprey nesting, trumpeter swans, and waterfowl concentrations. Construction activity including demolishing roads and bridges and hauling off large amounts of material would cause temporary disturbances to bird communities due to noise and the presence of heavy equipment, likely causing a behavioral response to flee the area. No long-term impacts to bird population are anticipated, although a transition to communities more

typical of brackish environments is likely. Felling of any potential nesting trees would occur prior to the nesting season.

Mammals: A couple of small seal haul-out locations have been reported at the Duckabush estuary near the main river outlet. Impacts to marine mammals would result from noise disturbances caused by bridge construction activities, which could cause behavioral response such as fleeing, or interfere with ability to locate prey. Underwater noise generating activities such as drilling and casting of piers would occur farther up in the estuary during low tides and low flows, and therefore are not expected to exceed thresholds that would cause physical harm. If work occurs from a platform on top of estuary substrate, this would further minimize noise effects. Impacts to other aquatic mammals like river otter, beavers, and muskrat would derive from noise and turbidity associated with construction. These impacts may result in the response to flee the area, but would not have any long-term impacts to populations in the project area.

Rare, Threatened, or Endangered Species: Impacts to ESA-listed species are similar to those described for fish, birds, and mammals. Through coordination with NMFS and USFWS, the ESA-listed species and critical habitat that the Corps consulted on include the following determinations: Likely to Adversely Affect bull trout, Puget Sound Chinook salmon, Hood Canal Summer chum salmon, and Puget Sound steelhead; Not Likely to Adversely Affect critical habitat for these three salmonids; and Not Likely to Adversely Affect Southern Resident killer whale or its critical habitat. No marbled murrelet or spotted owl nests occur within disturbance range of the site. (See appendix J for ESA consultation documents.)

Cultural Resources

The Duckabush site contains the Highway 101 causeway, including two bridges. Of the two bridges on the causeway, one (the Duckabush Bridge) is listed in the NRHP. The second bridge has been inventoried and recommended ineligible but has not been formally evaluated. One archaeological site is located in the Duckabush project area and has not been formally evaluated. Table 6-1 lists the known cultural resources located in the Duckabush site and the potential effect based on the current project design. Impacts to cultural resources are documented in section 5.3; see tables 5-11 and 5-12.

The Corps has prepared a Programmatic Agreement outlining the Section 106 process that will be followed in PED (Appendix D). The PA is the mechanism for Section 106 compliance as long as the PA stipulations are implemented in PED. The PA includes which Section 106 tasks need to occur prior to construction (e.g. fieldwork), how Section 106 consultation will occur, how determinations of eligibility will be made, how findings of no adverse effect will be determined, how findings of adverse effects will be made, and how the PA will be implemented, and a dispute resolution procedure. In addition, the PA provides for a variety of treatment measures that can be used for mitigation of an adverse effect (See Appendix E of the PA). The treatment

measures are standard types of mitigation actions used for adverse effects and the costs of these treatment measures have been taken into account during cost estimation for this project.

Table 6-1 Duckabush Estuary Archaeological Sites

Duckabush Estuary Archaeological Sites				
Site Number*	**Description**	**NRHP Eligibility**	**Location**	**Potential Effect to Resource Based on Current Design****
45JE362	Duckabush Orchard	Unevaluated	In project area	Potentially affected
Duckabush Estuary Structures				
Description*	**Date Constructed**	**NRHP Eligibility**	**Location**	**Potential Effect to Resource Based on Current Design****
Duckabush River Bridge	1934	Listed on NRHP	In project area	Adverse effect with proposed removal
Northern Distributary Channel Bridge	1934	Unevaluated	In project area	Adverse effect with proposed removal

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

**Project designs could change in PED. The effect or lack of effect to the resources is based ou the current information to date and is subject to change if project designs change.

Socio-Economic Resources and Human Environment

Land Use: The Duckabush River Estuary site will convert only 0.2 acres Prime and Unique Farmland and 0.2 acres Statewide Important or Local Important Farmland to tidal wetlands according to NRCS consultation. This accounts for less than 0.001% of farmland in Jefferson County. Given this small fraction, impacts to farmland would be minor and insignificant. The individual farmer(s) would be compensated for their loss during the purchasing agreement with the local sponsor and the loss of crop production would likely be absorbed by other nearby farms. Duckabush includes privately held, commercial, Jefferson County, and state and Federal lands (U.S. Forest Service), with public as the dominant ownership at 87% of the total site acreage. Property acquisition would occur by the local sponsor. Minor land use changes are the only anticipated long-term impact from this project.

Commercial Fisheries: Restoration of tidal wetlands at Duckabush would support fish and wildlife species by creating additional habitat for foraging and refuge. Impacts from restoration of sediment transport process to shellfish habitat at the Duckabush estuary will be taken into careful consideration during the next phase of design to avoid short-term and long-term effects.

Recreation: Temporary impacts to recreation are likely due to limited access to such areas during bridge and road replacement. Recreation such as increased bird watching opportunities may increase as more estuary dependent species use the area; however, benefits to recreation are incidental to the project as there will be no expenditure toward increased access or recreation features.

Transportation: Transportation impacts will be short term during the construction of the new Highway 101 Bridge, altering the interchange at Duckabush Road and the new bridge at Shorewood Road. The Corps would design and sequence the work to minimize traffic interruptions and delays. Bridge modification would conform to current bridge design safety standards applicable to the type and size of bridge being modified.

Public Safety: There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety and will allow for predicted sea level change.

6.1.1.13 *Site Summary Statistics*

- Acres Restored: 38 acres of scarce tidal marsh and estuarine mixing zone
- Removes 1,270 linear feet of tidal barrier, roadway, and shoreline armoring
- Total Project Cost: $90.5 M (refer to Table 6-2 for cost summary)

Table 6-2. Project Cost Summary – Duckabush River Estuary

Project Cost Component	Project First Cost ($1,000s; October 2015 price level)
Construction and Real Estate	
Construction Costs (including mitigation)	$17,473
Real Estate Costs (including relocations)	$48,115
Planning, Engineering and Design (PED)	$16,174
Construction Management (CM)	$6,401
Monitoring	$205
Adaptive Management	$2,151
Total Estimated First Cost	**$90,523**
Amortized Cost (3.125% discount rate[1])	$3,711
Annual OMRR&R[2]	$122
Total Average Annual Cost (AAC)	$3,833
Total Benefits (AAHU)	12.3
Total AAC / AAHU	**$312**

[1] Includes interest during construction (IDC). [2] Operations, maintenance, repair, replacement & rehabilitation (non-Federal sponsor responsibility)

6.1.2 Nooksack River Delta

6.1.2.1 *Site Description, Geographic Location & Context*

The Nooksack River is the northernmost of the 16 major river deltas in Puget Sound and originates from glaciers on and around Mt. Baker, a 10,700-foot-high peak in the Cascade Mountains. In the upper watershed, three main forks converge before the river enters the flatter,

agricultural lowlands. The Nooksack River delta is centered on Lummi Nation lands north of Bellingham (Figure 6-4). It encompasses nearly all of the Nooksack and Lummi River estuaries below Ferndale, Washington. The Lummi River, located in the lowland estuary and discharging to Lummi Bay, was once the main discharge route for the Nooksack River. The Lummi River is now mostly disconnected from the Nooksack River and only receives occasional high flows from the Nooksack through a culvert. The Nooksack River currently discharges to Bellingham Bay near the community of Marietta. The project area covers parts of the Lummi Nation lowlands as well as agricultural land south of Ferndale. Almost the entire project area lies below the 100-year flood elevation.

The lower Nooksack River has been significantly altered. Large changes to the channel morphology of the Lower Nooksack River occurred after western settlement of the region in the second half of the 19th century. The flow path of the Nooksack River has been modified since the mid-19th century beginning with active removal of large wood, draining, diking, and levee construction. Prior to 1860, the Nooksack River emptied into both Lummi and Bellingham Bays with flows shifting between the two outlets over time, depending on logjams. In the late 1800s, the Nooksack River was diverted to drain into Bellingham Bay.

Prior to the diversion and development, the lower Nooksack River consisted of numerous channels and sloughs, and had a major outlet into Lummi Bay. After the diversion of the Nooksack River into Bellingham Bay, the Lummi River became a high water overflow channel from the Nooksack River at RM 4.5. During low flow conditions, the Lummi River acts as a slough, dominated by tidal influence. During periods of Nooksack River high flows, the Lummi River carries a small amount of fresh water to Lummi Bay.

Historically, the lower Nooksack and Lummi Rivers were associated with numerous estuarine and tidally-influenced riverine wetlands, but well over half of this habitat was drained and diked for conversion to agricultural use. The Nooksack River has a heavily impacted floodplain and very poor riparian conditions throughout the mainstem and most tributaries. Dikes and levees, lining 33% of the total shoreline, have converted nearly all of the mainstem Nooksack River to a single channel, resulting in a major loss of slough, side channel, and off-channel habitat as well as significantly shortening and simplifying the previously long and complex shoreline. In fact, the historical delta shoreline was 47% longer than it is today (Simenstad et al. 2011). In addition to channel confinement, wetlands have been filled, compounding the loss. These floodplain impacts are believed to be one of the greatest salmonid habitat problems in the downstream project areas. The entire length of the mainstem Nooksack River also has a severely degraded riparian condition, with remarkably poor shade levels and most reaches with little to no canopy cover.

In general, the majority of fish and wildlife populations found within the Nooksack River basin are in a depressed state in relation to their historic condition. The Nooksack River system

supports nine species of salmonids, represented by more than 20 distinct stocks that are separated by their run timing and spawning location. Three of these species are listed under the Endangered Species Act: Puget Sound Chinook, Puget Sound steelhead, and Coastal/Puget Sound bull trout. The Nooksack River is one of five geographic areas considered essential for recovery of the Puget Sound Chinook Evolutionarily Significant Unit. Other anadromous salmonid species found in the Nooksack River include riverine sockeye, Coho, even-year and odd-year pink, and chum salmon; summer and winter steelhead; and coastal cutthroat trout. Runs of all of these species have declined significantly from historic levels.

The Nooksack floodplain has suffered a substantial loss of its tidal freshwater and estuarine wetlands from 8,785 acres recorded in U.S. Coastal and Geodetic Survey maps in 1888 down to only 3,211 acres remaining today representing a 64% loss. This includes a 71% loss of vegetated tidal wetlands. More than half of the remaining acreage is disconnected from natural hydrology by dikes, roads, and tidegates. This area is important habitat for migratory shorebirds of the Pacific Flyway, waterfowl, trumpeter swans, Canada geese, and the Wrangell Island snow geese.

While this is a substantially degraded floodplain, it is a key candidate for broad areas of restoration because of having no major cities or development that preclude restoration work. The proposed restoration at the Nooksack River Delta would modify levees, roads, and other hydrological barriers to restore riverine and tidal flow and sediment transport and delivery processes to the Nooksack River Delta, restoring 1,807 acres (or 20% of the whole floodplain available for restoration) of scarce tidal freshwater wetlands. This represents a rare opportunity to restore such a substantial portion of a Puget Sound delta.

6.1.2.2 *Site-Specific Goals & Objectives*

The goal of this project includes restoration of estuarine emergent marsh, scrub-shrub wetlands, and forested floodplain along the Nooksack River delta to improve connectivity and reduce fragmentation along the channel. The following are the site-specific objectives for the Nooksack River Delta, and all are applicable for the 50-year period of analysis:

- Reconnect and restore freshwater input to lost floodplain habitats including channel meander zone, shoreline complexity, and shaded aquatic habitat in the Nooksack River Delta.
- Restore tidal inundation to reconnect lost tidally influenced area including estuarine and freshwater tidal wetlands and tidal channels in the Nooksack River Delta.
- Re-establish intertidal and shallow sub tidal topography of the Nooksack River Delta to restore tidal prism and salinity gradient to increase nearshore habitat capacity and productivity for fish, birds, and other estuarine species.
- Improve aquatic habitat connectivity between lower river systems and upstream habitat networks of the Nooksack River.
- Restore a more natural riparian corridor along the Nooksack River Delta.

6.1.2.3 *Site-Specific Constraints*

There are a number of site-specific constraints that a recommended plan would attempt to avoid during formulation. The following are a list of notable issues that constrain the plan formulation:

- The project cannot prevent the use of Ferndale Road, Marine Drive, Kwina Road, Haxton Way, Hillaire Road, and Slater Road. These roads provide the only access to portions of the Lummi Indian Reservation, and the only access to the Lummi Island ferry terminal located on the Lummi Peninsula. Slater Road and Marine Drive are part of the main transportation corridor to two of the industries in the Cherry Point Heavy Impact Industrial Zone. When both roads are closed, access to the Reservation, the Lummi Island ferry, and the Cherry Point industries is through, or to the north of, the City of Ferndale, approximately 2 miles north of Slater Road. This detour can more than double travel times to and from Bellingham and result in severe congestion in the City of Ferndale. These road closures have substantial impacts on the economic, public health, and safety of the affected areas (FEMA 2015).
- The Nooksack Tribe and Lummi Tribe are federally recognized tribal nations that have treaty-reserved fishing, hunting, and gathering rights in the project area. Negative effects to tribal interests will be avoided. Increasing flood risk to significant areas of tribal lands should be avoided to the extent practicable.
- The project will avoid a single known HTRW site located approximately one half mile east of the Slater Road/Nooksack River bridge.
- The project will avoid two mitigation banks downstream of the project area and will not directly benefit the mitigation banks.

6.1.2.4 *Initial Plan Formulation*

Previously existing plans for this restoration site were considered during the Study Team's initial plan formulation process. Elements found in the 2005 salmon recovery chapter are included in the Nearshore Study design alternative (WRIA 1 Salmonid Recovery Plan), the 1999 Whatcom County Flood Hazard Management Plan (CFHMP), and the Lummi Multi Hazard Mitigation Plan (2004, 2007, 2010). The Corps used aspects of these plans as a starting point for initial plan formulation activities.

As described in section 4.1, a suite of 21 different management measures were identified for implementation across Puget Sound. Management measures identified for this study are fully outlined in the Management Measures for Protecting and Restoring Puget Sound Nearshore (Management Measures Technical Report, Clancy et al. 2009). Structural measures (e.g., armor removal, dike removal, channel rehabilitation, etc.) and non-structural measures (invasive species control, physical exclusion, public education, etc.) were identified and evaluated. A summary of the 21 management measures and their relationships to nearshore ecosystem processes are shown in Table 4-1. As described in section 4.1, the 21 management measures

were classified into three groups: restorative measures, prerequisite measures, and protective measures. Of the 21 management measures originally identified, nine management measures were carried forward in the formulation of alternative plans. These measures exert long-lasting effects on ecosystem processes and will often provide the best opportunity of achieving complete restoration of processes, directly meeting the planning objectives of this study.

Based on the screening described in section 4.1, the study team evaluated which of the nine remaining management measures could be implemented at the Nooksack River Delta site. The team qualitatively determined whether the identified measures met the site-specific planning objectives and generally avoided site-specific planning constraints. Based on this evaluation, one additional non-structural measure, residential relocations, was identified as a possible feature for the Nooksack River Delta. The following nine management measures were carried forward for evaluation at this site:

- Armor removal for streambank restoration and reconnecting floodplain habitat
- Dike removal or modification for floodplain freshwater marsh restoration
- Setback levees to maintain existing levels of flood risk management
- Riparian revegetation for shading, nutrient inputs, and complexity of bank habitat (non-structural measure)
- Large wood placement for increased habitat complexity
- Partial restoration of river flow to Lummi River through installation of water control structure at confluence of Lummi and Nooksack Rivers; structure intended to facilitate transfer of freshwater and sediment to the Lummi River
- Regrading of the Lummi River to allow for more frequent engagement by fluvial flows from the upper watershed
- Residential relocations (non-structural measure)

These measures were combined to form a number of viable alternatives that attempted to meet objectives and avoid constraints. The size and scale of measures were identified to take advantage of existing topography and using the existing flood risk features in the area where applicable. Based on the initial plan formulation, evaluation, and screening activities summarized above, one alternative was identified that meets the study objectives, avoids constraints, and restores critical habitat for nationally significant resources.

6.1.2.5 *Summary of Proposed Action*

The restoration proposal includes actions on both the Nooksack River and Lummi River. Portions of the Nooksack River's right and left bank dikes will be removed, allowing the river to be reconnected to historical tidal areas and floodplain habitats. A new setback levee will be constructed along the right bank of the Nooksack River to maintain existing levels of flood risk management in the area while still allowing reconnection of high value floodplain habitats. As

described above, the setback levees are required to maintain social and tribal acceptability at the site. The setback levee will generally follow the existing Ferndale Road alignment, as the existing embankments are already raised and the road provides primary access to portions of the Lummi Indian Reservation.

No setback levees are proposed for the left bank of the Nooksack River because the restored area is uninhabited north of Marine Drive and ties into high ground. In addition to the levee removals and setback levee construction on the Nooksack River, large woody debris structures will be installed to promote hydraulic stability and improve habitat complexity. On the downstream end of the project footprint, a flood-prone portion of the community of Marietta will be relocated to restore a small portion of the floodplain, avoid flooding impacts from the left bank levee removal, and avoid additional project costs associated with providing flood risk management features to this relatively small area.

A new water control structure (i.e., diversion feature) will be installed at the confluence of the Lummi and Nooksack Rivers. This structure is intended to facilitate transfer of freshwater and sediment to the Lummi River, while preventing avulsion of the mainstem to the west. The Lummi River channel will be regraded to reconnect it to Nooksack River flows, allowing the Lummi River channel elevation to better match the Nooksack River channel at the confluence, increasing conveyance capacity, and encouraging normal geomorphic processes in the river.

On the Lummi River, approximately 12,000 linear feet of berm would be removed to regain all of the shoreline complexity and dynamic shoreline processes on the north bank in the vicinity of North Red River Road, west of Haxton Way. A new setback levee will be constructed along the north bank of the Lummi River to allow reconnection of high value floodplain habitats while maintaining existing levels of flood risk management in the area. As described above, the setback levees are required to maintain social and tribal acceptability at the site.

Finally, the restoration proposal includes several road removals and/or relocations. Portions of existing roadways will be removed or raised to allow for floodplain restoration in the areas where levees are removed. Construction of new bridges or installation of culverts on both the Nooksack and Lummi Rivers will allow tidal exchange across the restored Nooksack River Delta. Please refer to the Engineering Appendix for a full description of road/bridge modifications included in the proposed alternative.

The restoration at the Nooksack River Delta is intended to complement, but not depend on, the implementation of the proposed Lummi Nation Wetland and Habitat Bank (Lummi Nation 2008). The two mitigation bank features would be constructed by the Lummi Nation and would not be implemented as part of a federally funded restoration project; mitigation bank features are not included in the proposed Federal project footprint and the area of hydraulic effect of the Federal project does not overlap the mitigation bank areas.

Figure 6-4 depicts the key design elements at the Nooksack River Delta.

6.1.2.6 *Separable Elements Analysis*

To help inform initial plan formulation and analysis, a qualitative evaluation of three different geographical elements of the Nooksack River Delta site was completed. The three areas evaluated included (1) Lummi River Area, (2) Diversion Control Area, and (3) Nooksack River Area (Figure 6-3). A summary of the results of this qualitative evaluation are included below:

Summary of Costs and Benefits:

	Area 1 – Lummi River	**Area 2 – Diversion Control**	**Area 3 – Nooksack River**
% of Total Project Cost	44%	6%	51%
% of Benefits	18%	6%	76%

The Nooksack River Area of this site provides the majority of ecosystem restoration benefits as calculated in the Ecosystem Outputs model and accounts for a majority of associated costs. Inclusion of the Lummi River Area provides about one-fifth of the ecosystem restoration benefits at this site for a lesser percentage of total project cost compared to the Nooksack Area. Installation of the proposed water diversion structure represents a small portion of the Ecosystem Outputs score and a corresponding small fraction of project costs; however, this project component is a critical need for ESA-listed salmonids in this watershed.

Restoration of both channels of the river, as well as providing the fish passage and flow regulation through the proposed diversion structure, is critical to achieve comprehensive ecosystem benefits at this site. Levee removal provides habitat capacity for juvenile salmon rearing, and each additional area of floodplain restoration supports more unique fish as they distribute among the rearing and refuge habitat that becomes available; therefore, it is important to restore both river channels, and to add as much shoreline length and salmon habitat capacity as possible. Installation of a water diversion structure would provide year-round flow and solve a fish passage issue in the five miles of the Lummi River to allow adult salmon access to spawning areas in the greater Nooksack watershed. ESA-listed salmon populations are currently suffering from pre-spawn mortality, which would be remedied by providing fish passage with the diversion structure. Lack of flow and fish passage also limits juvenile salmon migration outward to parts of the estuary that are underutilized and can provide greater productivity and survival.

The Nooksack/Lummi delta overall has lost over 70 percent of its historical estuarine mixing wetlands. In addition to providing ESA species habitat, the Lummi River area represents an important area of approximately 325 acres of wetlands restoration that would significantly add to the sparse wetlands available along this channel. Restoration would provide cooler water temperatures in this channel. Finally, restoration of both distributary channels provides foraging habitat for Great Blue Herons as well as beaver, mink, and muskrat habitat. The aquatic-oriented

mammals are likely to set up residence on only one side of each river channel, so restoration along both banks of both river channels will benefit additional individuals and family groups expanding the regional populations.

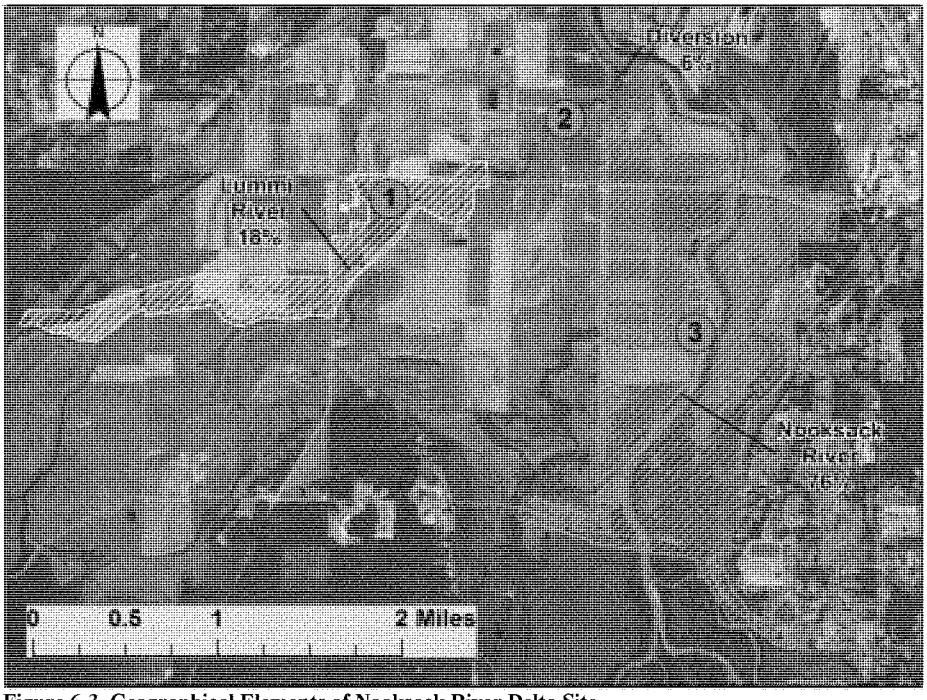


Figure 6-3. Geographical Elements of Nooksack River Delta Site

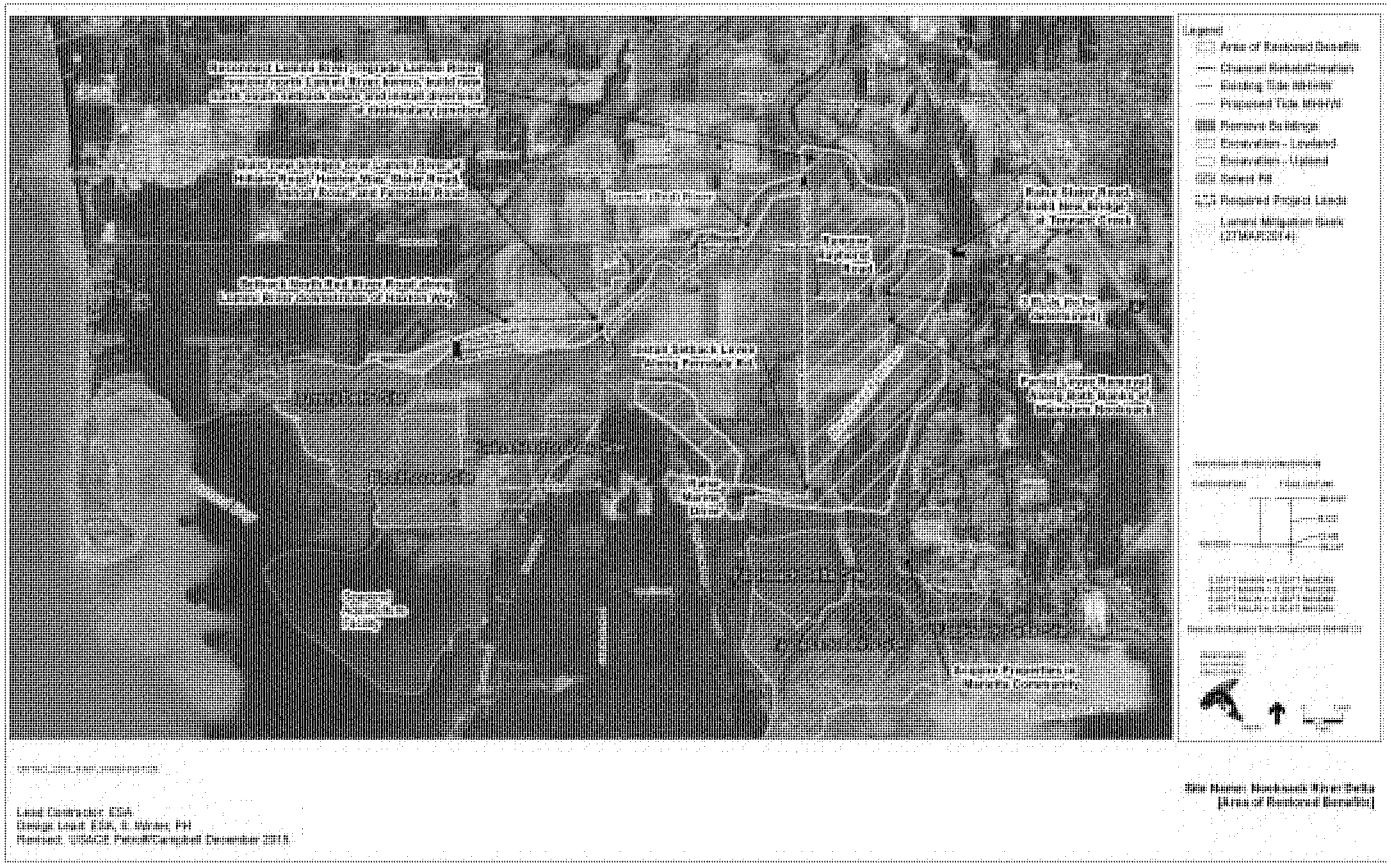


Figure 6-4. Nooksack River Delta

6.1.2.7 *Hydrology & Hydraulics*

Flood Limits: The hydraulics and hydrology for all restoration sites in the Puget Sound Nearshore Ecosystem Restoration Project were evaluated using an area of potential hydraulic effects specific to the construction requirements for each particular site. The upstream and lateral limits were set according to the 1% AEP (100-year) base flood elevation as determined by the FEMA Flood Insurance Study for unincorporated Whatcom County, community 53073C (revised 2007). The seaward limit was taken as the downstream extent of most estuarine sediments visible on aerial photographs. The base flood elevation as determined by FEMA ranges from over 12 feet (NAVD88) near Bellingham Bay to approximately 25 feet at the junction of the Lummi and Nooksack Rivers, a distance of about 4.6 miles.

Modeling: Current water surface profiles from 1991 as reported in the FEMA Flood Insurance Study will need to be revised to reflect the proposed changes in the floodplain. To forecast the new water surface profiles, a 2-D hydraulic model will have to be implemented in PED that reflects the proposed geometry of the delta and the planned design and operations of the engineered diversion structure. An existing 1-D unsteady hydraulic model (FEQ) has been developed by Whatcom County and the Lummi Nation. This model could be used to assist the programming of a 2-D HECRAS model of the Nooksack River Delta. The 2D RAS model would investigate water surface elevations under future without-project and future with-project conditions. The modeling is required to establish the final levee setback elevations and alignments, design bridge piers and abutments as well as to confirm the extent of benefits for the restored area. A geomorphic analysis and sediment transport model will be completed in PED to consider channel response to setback levees over the project life both within and adjacent to project boundaries as part of the levee design and the benefits optimization. In certain locations, such as at the diversion structure, a 3-D model may be required to support the design of the structure at an appropriate cost-effective scale.

Existing Levee System: After damaging floods in the 1920s and 1930s, both sides of the Nooksack River were lined with levees from Ferndale to just upstream of the Marine Drive Bridge. These levees primarily protect agricultural lands. The levees are non-Federal, and owned by Whatcom County and the City of Ferndale. Portions of Marine Drive serve a role in flood risk management, in that access across the Nooksack River is preserved during moderate flooding. The project plan is to remove the Dean Foods levee and to remove portions of the Rayhorst levee downstream of Slater Road.

The Nooksack Delta has three leveed areas listed in the National Levee Database (shown in Figure 6-5):

- The Ferndale/Nooksack levee system consisting of Rainbow Slough, Rayhorst, Sigardson, Ferndale Water Treatment Plant, and Ferndale levees along with high ground,

Haxton Way, and North Red River Road provide flood risk management to the largest area.

- The Red River Levee provides flood risk management to the Lummi Delta and is entirely on Lummi Tribal Lands.
- The Dean Foods levee area is located on the left bank of the Nooksack River. The Dean Foods levee is no longer maintained and has been abandoned as a levee. The land behind and including the Dean Foods levee up to high ground has been purchased as a conservation easement by WDFW.

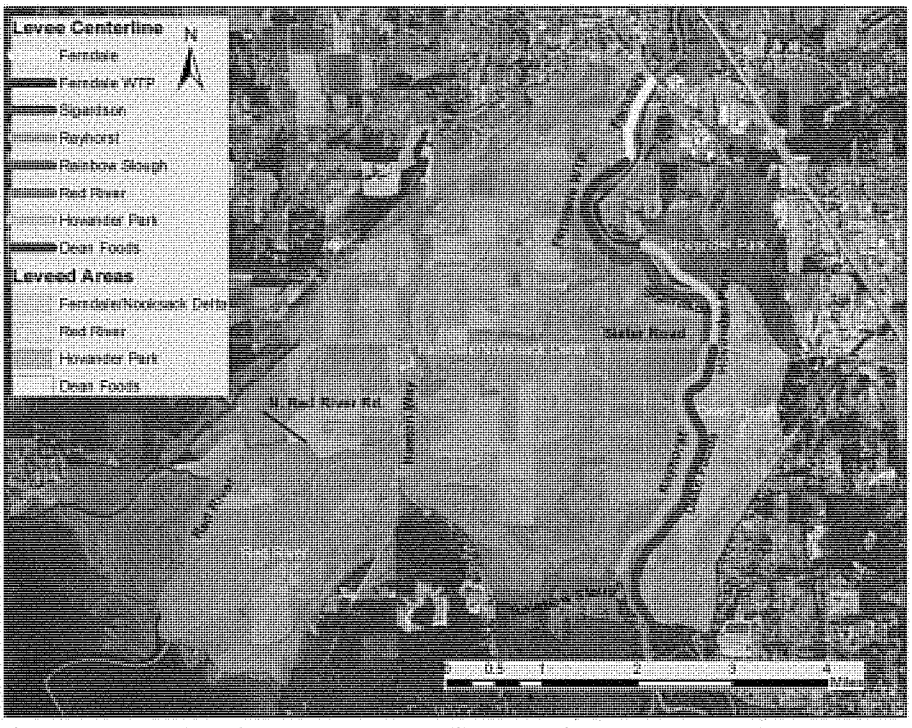


Figure 6-5. Leveed Areas in the Nooksack Delta (Source: National Levee Database)

Table 6-3 the existing levees in the Nooksack River Delta. The level of residual risk is given, where available, as the AEP for the overtopping flow. The Levee Screening Action Classification (LSAC) for all right bank levees in the Nooksack Delta is "4" or "low risk warranting priority actions to reduce risk."

Table 6-3. Levee details for Nooksack Delta (Sources: Corps Levee Screening, Whatcom County)

Levee System	Levee	LSAC Rating	PL 84-99 (Y/N)	Level of Residual Risk (AEP)	% Area Inundated > 2 ft.
Ferndale/Nooksack Delta					
	Rainbow Slough	4	Y	10%	82%
	Rayhorst	4	Y	2%**	83%
	Sigardson	4	Y	10%	94%
	Ferndale WTP	4	Y	20%	99%
	Ferndale	4	Y	20%	98%
	Red River Road	NA	N	20%††	NA
Red River					
	Red River	4	Y	20%	100%
Hovander/Dean Foods					
	Hovander Park	NA	Y	10%	100%
	Dean Foods	NA	N	NA	NA

** Levee screening has 10%, 2% is per Whatcom County including recent upgrades.
†† Assumption is the same as Red River Levee, which was built at the same time.
NA = Not Applicable.

6.1.2.8 *Justification of Setback Levees*

The NER Plan for restoration of the Nooksack River Delta includes removing existing levees along both the Nooksack and Lummi Rivers to restore freshwater and tidal hydraulic connectivity to floodplain habitats that have been cut off due to levees being located directly adjacent to the riverbank. To balance restoration opportunity while managing flood risk on adjacent floodplain lands, the NER Plan also includes construction of new setback levees along the floodplain restoration project area.

As described above, the floodplain in the project area is currently constrained by non-federal levees. Most existing levees are enrolled in the PL 84-99 program, have LSAC ratings of 4 (low risk), and generally provide levels of residual risk ranging from 10% to 20% Annual Exceedance Probability (AEP). The restoration project recommends reconnecting and widening the floodplain by moving the existing levees further from the Nooksack River, i.e., setting back the levees to allow natural processes to occur across a restored, wider floodplain.

The NER Plan at the Nooksack River Delta, which includes setback levees, reasonably maximizes ecological restoration, avoids a large-scale takings of Native American reservation land, and is consistent with the Corps efforts to promote integrated water resources management across the Nation. By considering economic benefits, ecosystem quality, and health and public safety, proposed actions at the Nooksack River Delta are compatible with the risk to natural resources (natural and beneficial functions of floodplains) and human resources (life and property). This integrated approach to water resource planning considers ecosystem restoration and flood risk management as two key objectives needed in the watershed.

Design of Setback Levees

The setback levees are not intended to provide direct ecosystem restoration benefits; rather, the recommended setback levees are designed to provide the current level of flood risk management to adjacent lands – primarily Lummi Nation Reservation lands – not included in the restoration footprint. The setback levees are designed to tie into higher elevation features and will follow the road alignments, as the embankments are already raised and the roads provide primary access to portions of the Lummi Reservation. The setback levees are included as features of the NER Plan.

To inform design and cost estimates for the NER Plan at Nooksack, the study team completed a qualitative evaluation of different levels of residual risk for the setback levees. The team evaluated setback levees that provide a lower level of residual risk than the existing levees, setback levees that provide an equivalent level of residual risk as the existing levees, and setback levees that provide a higher level of residual risk compared to the existing levees.

Setback levees that provide equivalent levels of residual risk to the existing levees are the minimum cost effective structure necessary to realize ecosystem restoration outputs at the site. Setback levees that provide a lower level of residual risk are not cost effective; designing the setback levees at a lower level of residual risk will provide similar ecosystem outputs at a higher cost. Setback levees that provide a higher level of residual risk would adversely impact significant tribal resources as described below and are not recommended as part of the NER Plan for this site.

Based on this qualitative evaluation, the NER Plan includes setback levees designed to maintain existing levels of residual risk. The proposed project does not intend to decrease the level of residual flood risk for the leveed area. For example, at the Nooksack River, the existing Rayhorst levee is enrolled in the PL 84-99 program and has a level of flood risk management established by the Corps in Levee Screening as 10% AEP. The proposed setback levee will be constructed to the same 10% AEP level of residual risk.

Quantities for setback levees take into account the uncertainty in existing topography, soils information, and hydraulics and reflect the fact that the setbacks will create slow flowing backwater areas away from the main flow of the river. Fill volumes and associated levee heights will be confirmed in the pre-construction, engineering, and design phase when soils information and land elevations are available, and levee foundation analysis and hydraulic modeling is completed.

Induced Flooding Analysis

The study team completed an induced flooding analysis to determine whether mitigation for induced flooding (i.e., inclusion of setback levees) is justified as part of this ecosystem restoration project. Per Corps guidance (ER 1105-2-100, para E-18.f), mitigation is appropriate when economically justified or there are overriding reasons of safety, economic or social concerns, or a determination of a real estate taking (flowage easement, etc.) has been made.

In the absence of detailed hydraulic modeling by the Corps, the water surface for inundated area has been set at an elevation of 17 feet North American Vertical Datum of 1988 (NAVD88) based on flooding from right bank of the Nooksack River below Slater Road for the 2% AEP (50-year) event of 57,000 cfs. According to Whatcom County, this is the current level of residual risk for the Rayhorst Levee (Figure 6-5). The 2% AEP leveed water surface in this reach, as modeled by Whatcom County is 22 feet NAVD88 at the north end of Rayhorst levee and 17 feet NAVD88 at the south end. The levee toe lies mostly near or below 17 feet NAVD88. Assuming that levee removal causes a substantial lowering of water surface, the 17 foot elevation was chosen as a reasonable low end expected level of inundation for the 2% AEP event. On Figure 6-6, the inundated area with setback levees in place is about 2 square miles. An additional 7.5 square miles are inundated if there are no setback levees.

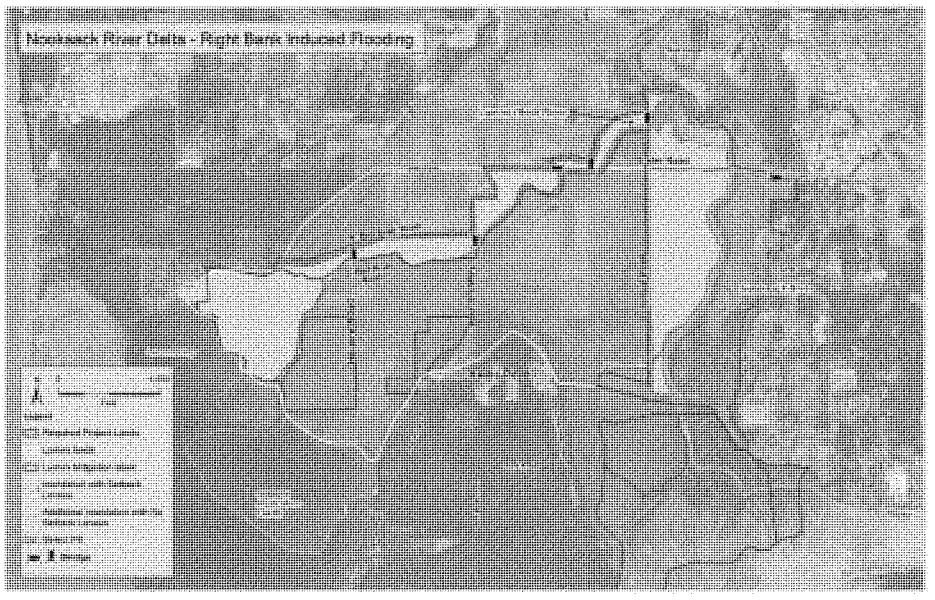


Figure 6-6. Inundation of project area with and without setback levees

If the existing levees are removed and no setback levees are constructed, approximately 3,900 acres of land – including 2,800 acres on Lummi Nation reservation lands (approximately 23% of the Lummi Reservation) – will be at increased risk of inundation (Figure 6-6) during frequent flood events. Under this scenario, substantial induced flooding to a Native American reservation would occur. Based on the analysis summarized in the previous paragraph, additional flooding (on the order of feet) for flood events more frequent than the 10% AEP (10-year) event (e.g. 2, 5, up to 10 year events) would occur under this scenario. Events less frequent than 10% AEP will

overtop the levee, so there would be no change from current conditions for those events (e.g. 10 year up to 25, 50, 100+ year floods).

Justification of Setback Levees

Mitigation for induced flooding is also appropriate when there are overriding reasons of safety, economic, or social concerns. There are a number of significant, overriding reasons of safety, economic, and social concerns at the Nooksack River Delta site, primarily tied to the Lummi Tribal Reservation. Item 4 of the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies (Public Law 89-80, as amended) states, "Federal water resources planning is to take into account international implications, including treaty obligations." The Lummi Nation reservation was established in the Treaty of Point Elliott in 1855. The reservation is located within the Lummi Nation's traditional territory; the reservation area and surrounding land has been occupied by the Lummi Nation since time immemorial. No authority currently exists for a State or Federal Agency to condemn or take land designated within this reservation. 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. Therefore, pursuing large-scale restoration involving inducing flooding beyond the current footprint cannot occur without Congressional action to modify the reservation and condemn or take land within the reservation for an ecosystem restoration project.

In addition, due to the limited land-base of the Lummi Tribal Reservation, loss of the use of those lands would significantly impact the social and cultural cohesion of the Lummi Nation. The Lummi Nation has strict codes relating to adversely affecting cultural sites and archaeological resources. The Lummi Nation's Code of Laws declares, "the integrity of the Lummi traditions, cultural heritage, and values is threatened due to encroachment of the dominant United States and Canadian societies and governments...strict tribal control over activities within the boundaries of the Lummi Reservation and tradition use areas within the ceded territory is vital to the future existence of the Lummi Nation." The Code of Laws also indicates that federal or state laws and/or policies shall not adversely affect the need for the Lummi people and the Lummi Nation to sustain its customs, practices, and traditions of its culture. In addition to the submerged and submersible lands within the jurisdiction of the Lummi Nation, cultural sites that may be adversely impacted without setback levees include at least 124 archaeological sites (historic debris scatters, pre-contact lithic scatters, lithic isolates, culturally modified trees, shell middens/camps, historic homesteads, pre-contact villages, and pre-contact burials). There are four known burial locations within the Lummi Nation and at least one traditional cultural properties that may be affected if large areas of the Lummi Reservation are inundated. A loss of the use of Lummi Nation lands and associated impacts to significant cultural resources present overriding economic and social concerns.

Finally, as described in the site-specific planning constraints for the Nooksack River Delta, the project cannot prevent the use of Ferndale Road, Marine Drive, Kwina Road, Haxton Way, Hillaire Road, and Slater Road to the extent practicable. These roads provide the only access to portions of the Lummi Indian Reservation, and the only access to the Lummi Island ferry terminal located on the Lummi Peninsula. Slater Road and Marine Drive are part of the main transportation corridor to two of the industries in the Cherry Point Heavy Impact Industrial Zone. When both roads are closed, access to the Reservation, the Lummi Island ferry, and the Cherry Point industries is through, or to the north of, the City of Ferndale, approximately 2 miles north of Slater Road. This detour can more than double travel times to and from Bellingham and result in severe congestion in the City of Ferndale. These road closures have substantial impacts on the economic, public health, and safety of the affected areas (FEMA 2015), presenting an overriding safety concern without setback levees included at the site.

The setback levees are included in the NER Plan at the Nooksack River Delta site and are integral in providing protection of tribal lands from induced flooding caused by the ecosystem restoration action. In addition, the setback levees are also appropriate mitigation features based on overriding reasons of safety, economic, and social concerns. The Corps has coordinated with the non-Federal sponsor and Lummi Nation during the formulation of this restoration site to ensure the project achieves restoration while still providing comparable levels of flood risk management to tribal lands. The Nooksack River Delta project is designed to achieve large-scale ecosystem restoration benefits while still being compatible with tribal interests. This project is consistent with the Federal trust responsibility to Native American Tribes and the Corps will continue to seek input from the Lummi Nation as project designs are refined. The Lummi Nation provided a letter of continuing support for the Puget Sound Nearshore study, including specific support for the Nooksack River Delta site. The letter also highlighted the importance of the Federal trust responsibility to the Lummi Nation.

6.1.2.9 *Operations & Maintenance*

Operations and maintenance costs for the Nooksack restoration are related to maintenance and repair of levees, culverts, roadways, and embankments as well as maintenance and repair of the bridges and the diversion structure. Additional maintenance tasks are the maintenance of plantings and removal of invasive plant species at the site. The annual OMRR&R estimate is approximately $705,000 per year; OMRR&R activities are a non-Federal sponsor responsibility.

6.1.2.10 *Public Review*

Site-specific comments received during public review were related primarily to concerns from the agricultural community regarding conversion of farmland for ecosystem restoration. The Lummi Nation submitted a letter of support for restoration at this site. The Corps and non-Federal sponsor will continue to coordinate with landowners and stakeholders.

6.1.2.11 *Risk & Uncertainty*

The study team has used a risk-based strategy in their approach to formulating the project from the early stages of the study. Key risks or uncertainties associated with this site include the following, along with the strategy to reduce risk as the study continues:

Earthwork Quantities

Risk and Cause: Earthwork quantities for setback levees, abutments, and other measures were determined based on available LiDAR data. In addition, no soil investigations have been done on site to characterize possible settlement of the setback levee.
Risk Management: Additional survey data, LiDAR and soils information will be obtained during the PED phase. Additional hydraulic modeling and geotechnical analysis will be conducted to refine the size and scale of setback levees. PED costs include estimates for both obtaining the required data and performing necessary engineering analyses. The CSRA for the project has identified risks associated with the variability in existing survey/ LiDAR data with varying resolution as well as uncertainty in future settlement of the setback levee. Cost contingencies reflect the uncertainty in quantities of material required for construction.

Bridges & Roads: Foundation and Placement

Risk & Cause: Bridge and foundation geometry is likely to change based on additional design during PED. Some elements of the proposed bridges may be adjusted based on additional analysis and design (e.g., longer spans, larger piers, or raising the bridges).
Risk Management: Additional survey data, LiDAR, and soils information will be obtained during PED phase. Additional hydraulic modeling and geotechnical analysis will be conducted to refine the size, scale, and alignment of the new bridges. PED costs include estimates for obtaining the required data and performing necessary engineering analyses. Cost contingencies reflect the uncertainty in quantities of material required for construction.

HTRW

Risk & Cause: Results of a Phase 1 Environmental Site Assessment indicate one HTRW site is adjacent to, but not within, the project footprint. Because detailed hydraulic modeling has not been completed, there is uncertainty about the potential of a hydraulic connection to the adjacent HTRW site in the future with-project condition.
Risk Management: Hydraulic modeling and groundwater flow analysis will be required during PED to confirm whether there is a hydraulic connection to the HTRW site adjacent to the project footprint. If there is a hydraulic connection, the non-Federal sponsor can implement measures outside of the project footprint to reduce risk associated with hydraulic connection. Measures could include relocation of a small drainage outlet near the site or actions to cut off the area of interest from the reconnected floodplain, including construction of a small berm or regrading a small area. Measures to reduce hydraulic connection to the

area of interest will be a non-Federal responsibility and can be completed prior to construction. In addition, the Corps could modify a small portion of the project footprint to avoid a hydraulic connection with the site. Potential measures to reduce this risk will not significantly affect the cumulative ecosystem benefits at the project site.

6.1.2.12 *Ecosystem Restoration Benefits*

As Figure 6-4 depicts, this site restores many critical ecosystem processes including sediment transport, freshwater input, tidal exchange, channel migration, exchange of aquatic organisms, detritus distribution, marsh accretion, overbank deposition, and natural topography features that form when riverbanks are allowed to overflow naturally and deliver overbank deposition. Restoration of this site, the fourth largest of the 16 Puget Sound deltas, provides substantial benefits to ESA critical habitat for Chinook salmon, steelhead, and bull trout as well as direct benefits to bald eagles and other raptors, waterfowl, and native amphibians. Additional benefits include the following:

- Reconnects and restores 1,807 acres of scarce tidal freshwater marsh and lost floodplain habitats, including restoration of highly productive tidal freshwater wetland habitats that support biodiversity and provide connectivity between land and sea (meets site-specific planning objectives #1 and #2).
- Re-establishes tidal inundation to intertidal and shallow sub tidal areas by removing 11,910 linear feet of armoring from riverbank for the benefit of fish, birds, and other estuarine species (meets site-specific planning objective #3).
- Improves nearshore and adjacent uplands connectivity for exchange of water, sediments, nutrients, woody debris, and freshwater-dependent mammals such as mink, river otter, beavers, and muskrat that cross both habitat types (meets site-specific planning objective #4).
- Restores sediment input for marsh accretion downstream from the project site for improved resilience of the estuary to effects of sea level change.
- Improves large acreages of habitat for Washington State Priority Species and Habitats for peregrine falcon, bald eagle, waterfowl, and shorebirds; will have downstream benefits for herring by improving water quality through wetland restoration and indirect benefits for the orcas seen offshore in summertime.
- Nearly doubles the shoreline length and adds valuable aquatic habitat complexity from its degraded, shortened, and armored condition by removing over two miles of human-built stressors.

Restores large river delta that provides valuable nursery habitat for juvenile threatened salmon species, increasing survival and supporting Puget Sound population recovery.

6.1.2.13 *Significance*

- Provides 25 percent of Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project
- Supports major portions of multiple recovery plans including, but not limited to Puget Sound Chinook Salmon Recovery Plan of 2005, Washington Comprehensive Wildlife Conservation Strategy of 2005, Northern Pacific Coast Regional Shorebird Management Plan of 2000, and Pacific Coast Joint Venture of 1996
- Tribal support for Nooksack Delta restoration
- Central to Whatcom County's comprehensive approach to managing flooding and restoring estuary habitat in the lower Nooksack River
- Complementary to multiple wetland restoration projects nearby and upstream from the proposed restoration site

6.1.2.14 *Site Specific Project Impacts*

Removal of 11,910 feet of armoring and tidal barriers for restoration of 1,807 acres of tidal wetlands and floodplain habitat will achieve long-term benefits that are discussed in the previous section (Ecosystem Restoration Benefits) , but will also have short-term construction impacts listed below that are necessary to achieve the benefits.

Physical Environment: Nearshore Processes and Structure

Processes, Physiographic Characteristics, Oceanography, and Sedimentation and Erosion: These resources would all be positively effected as described in the previous section (Ecosystem Restoration Benefits) primarily by providing unrestricted tidal and freshwater flow, reestablishing sediment transport and delivery, and reconnecting potions the Lummi and Nooksack Rivers with their floodplains.

HTRW: A Phase 1 Environmental Site Assessment was started in 2010 and completed in 2015 by members of the USFWS and the USACE, Seattle District (See Engineering Appendix). Preliminary results of this analysis indicate that there is one HTRW site, the Wilder Hazardous Waste Landfill site, located approximately a half mile east of the project; the HTRW site footprint and is adjacent to, but outside of the project footprint. The Phase 1 analysis determined there is a small risk of contaminants in the landfill being mobilized by possible flooding or increased hydraulic connection as a result of the proposed project. This risk can be mitigated by the non-Federal sponsor prior to construction. This risk is discussed in "Risk and Uncertainty" above, and is fully detailed in Appendix B – Engineering Appendix, Chapter 2.

Water Quality: Water quality would experience pulses of turbidity during breaching of levees, and the removal of five narrow bridges and replacement with wide-span bridge piers and culverts; however, all work would use BMPs including isolation devices such as cofferdams or equivalent, silt curtains, and timing work during low flows to prevent turbidity from affecting the

aquatic environment. Installation of water isolation devices may cause pulses of turbidity, but the duration of effect would only be a matter of hours and for an area not likely to exceed an estimate of 1,000 feet based on velocity of flow in the rivers. Long-term water quality conditions would improve by allowing unrestricted freshwater and tidal exchange in the estuary and attenuation of sediments and pollutants into reconnected floodplain wetlands. Additional water quality sampling may be required during PED to analyze water quality issues in the Nooksack to ensure any problems are not introduced to the Lummi through the proposed diversion structure.

Green House Gases: Construction machinery was estimated to have GHG emissions of 25,618 tons of CO_2 based on types of machinery that would be used and estimated duration of construction.

Underwater Noise: Machinery would cause underwater noise in the freshwater environment during bridge construction from drilling and cast in place for pier installation and vibratory pile driving for pile removal. Impacts from would be limited to 10-18 months at any one location and minimized by working during low flows when sensitive species are least likely to be present.

Biological Environment: Nearshore Functions

Vegetation: Temporary access routes can occur via the existing system of county and farm access roads. Staging areas will be determined during the PED phase. Areas free of trees and other native vegetation will be utilized to the extent practicable. Some areas would need to be cleared during construction, such as areas along the installation of the new bridges, excavation of the levees, and building of setback levees. The number and sizes of trees and other vegetation felled will be determined during PED phase. Replanting of disturbed areas would occur following construction. Patchy and continuous eelgrass grows downstream from the Nooksack and Lummi Rivers. Turbidity from construction would not be substantial enough to harm this aquatic vegetation.

Shellfish: Impacts to shellfish populations would be minimal, as all of the work occurs well upstream of the marine waters. Changes in water quality from directing water from the Nooksack River into the Lummi River and the potential impacts to shellfish beds in the Lummi Estuary will be minimized by project design and coordination with the Lummi Tribe. The next design phase for the Nooksack River Delta site will require careful attention to plans for diversion of flow from the Nooksack River to the Lummi River to ensure no negative effects occur to the shellfish operations in the estuary. For other macro-invertebrates within the project site, actions would have the short-term impact of disrupting or destroying benthic and epibenthic invertebrates. Once the stressors are gone, invertebrate colonization would follow a pattern of succession, with near complete recovery in one to three years (Hueckel and Buckley 1987, Martin 2012 pers. comm.).

Fishes: Herring are present downstream from the project site and the estuary serves as a migration corridor and rearing habitat for multiple species of salmonids including a rare run of spring Chinook salmon that make up a tiny fraction of the ESA-listed population. Negative effects would come from construction activities causing 1) increases in turbidity from excavation of fill, and 2) noise and vibration associated with large equipment operation for excavation and demolition. Elevated levels of turbidity could cause physiological damage to gills, and elevated noise could cause a behavioral response to flee or delay migration. Working within designated in-water work window of 16 July to 15 August when fish are less likely to be present and during low tides would minimize effects of noise and turbidity on fish.

Birds: This area hosts a variety of birds including eagles and other birds of prey, songbirds, and waterfowl concentrations in the upstream areas, as well as wading birds and water fowl in the downstream areas. Construction activity including demolishing bridges and levees, hauling off large amounts of material, and installation of new bridges and setback levees would cause temporary disturbances to bird communities due to noise and the presence of heavy equipment, likely causing a behavioral response to flee the area. Impacts from would be limited to 10-18 months at any one location and would not have any long-term negative impacts to bird communities. Felling of any potential nesting trees would occur prior to the nesting season.

Mammals: No impacts to marine mammals are anticipated as the work occurs well upstream of marine waters. Impacts to other aquatic mammals like river otter, beavers, and muskrat would derive from noise and turbidity associated with construction. These impacts would likely result in the response to flee the area, but would not have any long-term impacts to populations in the project area.

Rare, Threatened, or Endangered Species: Impacts to ESA listed species are similar to those described for fish, birds, and mammals. Through coordination with NMFS and USFWS, the ESA-listed species and critical habitat that the Corps consulted on include the following determinations: Likely to Adversely Affect bull trout, Puget Sound Chinook salmon, and Puget Sound steelhead; Not Likely to Adversely Affect critical habitat for these three salmonids; and Not Likely to Adversely Affect Southern Resident killer whale or its critical habitat. No marbled murrelet or spotted owl nests occur within disturbance range of the site (see Appendix J).

Cultural Resources

Impacts to cultural resources are documented in section 5.3; see tables 5-11 and 5-12.

The Nooksack River Delta restoration area contains 13 unevaluated archaeological sites ranging from shell middens, and lithic scatters and a historic debris scatter. In addition, the 13 previously inventoried historic properties located either within the restoration site area or directly adjacent to it. Of the 13 properties, five have been determined not eligible, six are unevaluated, and finally, the Marietta/Custer Grange Hall located just outside of the Nooksack River Delta area is

eligible to the NRHP. Table 6-4 lists the known cultural resources located either in or adjacent to the Nooksack River Delta site and the potential effect based on the current project design.

Table 6-4 Nooksack River Delta Archaeological Sites

Site Number*	Description	NRHP Eligibility	Location	Potential Effect to Resource Based on Current Design**
Nooksack River Delta Archaeological Sites				
45SH27	Pre-contact shell midden; Pre-Contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH170	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Unknown at this time
45WH526	Pre contact shell midden-possible village	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH723	Pre-contact shell midden; pre contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH734	Pre-contact lithic scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH742	Pre-contact isolate	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH847	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH848	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH862	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH863	Pre-contact lithic scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH896	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH907	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH908	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design

Nooksack River Delta Structures				
Description*	**Date Constructed**	**NRHP Eligibility**	**Location**	**Potential Effect to Resource Based on Current Design****
Janet's House-1816 Bayon Road, Bellingham	1930-1950	Unevaluated-WISSAARD states undetermined-SHPO	In project area	Appears that it will be affected based on current project design
Wylanoux House (Howell House)	1912	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Kwina Slough Levee	1927	Unevaluated	In project area	Appears that it will be affected based on current project design
Nooksack River Levee	1900, 1935, 1955	Unevaluated	In project area	Appears that it will be affected based on current project design
Lummi River Levee	1900	Unevaluated	In project area	Appears that it will be affected based on current project design
Jones House-1880 Marine Drive, Bellingham		Not eligible	In side project area	No effect as house has been determined not eligible
1850 Shady Lane-Historic single family residence	1950	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Scarborough-1857 Marine Drive, Marietta	1920	Not Eligible	In project area	No effect as house has been determined not eligible

White-1853 Marine Drive, Marietta	1915	Not Eligible	In project area	No effect as house has been determined not eligible
Marietta/Custer Grange Hall	1920	Eligible	Just outside project area	Appears that there will be no effect based on current project design
1835 Marine Drive-Historic single family residence	1925	Not Eligible	In project area	No effect as house has been determined not eligible
1801 Marine Drive Historic single family residence	1949	Not Eligible	In project area	No effect as house has been determined not eligible

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

**Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change.

The Corps has prepared a PA outlining the Section 106 process that will be followed in PED (Appendix D). The PA is the mechanism for Section 106 compliance as long as the PA stipulations are implemented in PED. The PA includes which Section 106 tasks need to occur prior to construction (e.g. fieldwork), how Section 106 consultation will occur, how determinations of eligibility will be made, how findings of no adverse effect will be determined, how findings of adverse effects will be made, and how the PA will be implemented, and a dispute resolution procedure. In addition, the PA provides for a variety of treatment measures that can be used for mitigation of an adverse effect (See Appendix E of the PA). The treatment measures are standard types of mitigation actions used for adverse effects and the costs of these treatment measures have been taken into account during cost estimation for this project.

Socio-Economic Resources and Human Environment

Land Use: As described in section 5.4.1, the change in land use in the Nooksack delta will convert approximately 1,600 acres of prime or important farmland according to NRCS consultation; however, this is less than 0.01 percent of farmland in Whatcom County. Given this small fraction, impacts to farmland would be minor and insignificant. The individual farmer(s) would be compensated for their loss during the purchasing agreement with the local sponsor and the loss of crop production would likely be absorbed by other nearby farms. Some properties may already have easements, or may involve property acquisition through purchases by the local sponsor; land use changes are the only anticipated long-term impact from this project. Many lands associated with the Nooksack River Delta are in tribal jurisdiction and would require close coordination with the Lummi Nation.

Commercial Fisheries: Restoration of tidal wetlands in the Lummi and Nooksack River estuaries would support fish and wildlife species by creating additional habitat for foraging and refuge. Impacts from diversion of Nooksack River flows to the Lummi River on shellfish beds in Lummi Bay will be evaluated and minimized during the PED phase.

Recreation: Temporary impacts to recreation are likely due to limited access to such areas during bridge replacements. Recreation such as increased bird watching opportunities may increase

long-term as more wetland dependent species use the area; however, benefits to recreation are incidental to the project as there will be no expenditure toward increased access or recreation features.

Transportation: Transportation impacts will be short-term during the construction of the six new bridges and raising portions of Slater Road and Marine Drive. The Corps would design and sequence the work to minimize traffic interruptions and delays. Bridge modification would conform to current bridge design safety standards applicable to the type and size of bridge being modified. The Corps would design and sequence the work to minimize traffic interruptions and delays. Bridge modification would conform to current bridge design safety standards applicable to the type and size of bridge being modified.

Public Safety: There would be no reduction to public safety at any of these sites; in fact, conforming to updated standards would likely improve safety and will allow for predicted sea level change.

6.1.2.15 *Site Summary Statistics*

- Acres Restored: 1,807 acres of scarce tidal freshwater marsh
- Removes 11,910 linear feet of armoring from riverbank, which is shown to increase rearing capacity of juvenile Chinook by more than 500% (Beamer and Henderson 1998)
- Total Project Cost: $261.8 M (refer to Table 6-5 for cost summary)

Table 6-5. Project Cost Summary – Nooksack River Delta

Project Cost Component	Project First Cost ($1,000s; October 2015 price level)
Construction and Real Estate	
Construction Costs	$99,187
Real Estate Costs (including relocations)	$99,452
Planning, Engineering and Design (PED)	$44,099
Construction Management (CM)	$17,455
Monitoring	$506
Adaptive Management	$1,106
Total Estimated First Cost	**$261,805**
Amortized Cost (3.125% discount rate[1])	$11,427
Annual OMRR&R[2]	$705
Total Average Annual Cost (AAC)	$12,132
Total Benefits (AAHU)	650.5
Total AAC / AAHU	**$19**

[1] Includes interest during construction (IDC). [2] Operations, maintenance, repair, replacement & rehabilitation (non-Federal sponsor responsibility)

6.1.3 North Fork Skagit River Delta

6.1.3.1 *Site Description, Geographic Location & Context*

The North Fork Skagit River empties into Skagit Bay south of La Conner, Washington (Figure 6-7). The Skagit River is critically important to all five species of Pacific salmon as well as steelhead and sea-run cutthroat due to the habitat productivity of large wilderness areas in the upper watershed upstream from the diked and developed floodplain, as well as the total areal extent of the aquatic habitat in the delta, which is the target for restoration efforts. It hosts 30 percent of all anadromous fish in Puget Sound and the largest populations of pink and chum in the contiguous United States (North Cascades Institute 2002). The Skagit River and its tributaries also host the largest populations of ESA-listed bull trout, steelhead, and wild Chinook in the Puget Sound Basin (USFWS 2004, Smith no date). While the Skagit hosts a large percentage of Puget Sound's salmon, the populations are a fraction of their historical levels. Declining salmon runs has led to a decrease in nutrient input to the river and a decrease in food available for bald eagles, bears, and over 100 other species of the northwest that rely on abundance and high nutritional value of salmon, including ESA-listed southern resident killer whales. Additionally, the depressed levels of salmon populations have all but eliminated the once great commercial fishing industry of Western Washington, severely reduced sportfishing, and significantly impacted the Native American tribes whose cultures center on salmon returns.

Over the last century, the Skagit River has lost around 75 percent of its off-channel habitat due to the diking of the river and land use practices; most of this loss has been in the lower Skagit Basin in the floodplain and delta area (Beechie et al. 1994, Collins and Sheikh 2002). Many beaver ponds, side channels, and sloughs once used by salmon have been disconnected from the main river channel. In the last century, the Skagit Basin has lost approximately 80 percent of historic estuarine delta habitat, including a loss of 35 percent of estuarine mixing habitat, 98 percent of low salinity transitional habitat, and 89 percent of its freshwater tidal habitat (Simenstad et al. 2011). The lower Skagit basin has lost approximately 45 percent of the historic side slough habitat (424,200 m^2) that provided critical rearing and refuge functions in the floodplain (Beechie et al. 1994). The Skagit Delta has lost approximately 75 percent of its distributary channel habitat (Beechie et al. 2001). A reduction in the number of side channels and sloughs, changes and reductions in the quality of riparian vegetation, and a reduction in the number of high quality stream channel pools has significantly reduced the amount of available refugia for juvenile salmonids. This means the salmon are at much greater risk of predation and they lose weight trying to fight strong river currents rather than resting and growing for ocean phase survival. The greatest loss of salmonid habitat has occured in the lower river and estuary where only 20% of the historical tidal wetlands and associated channels remain (Simenstad et al. 2011). The estuarine loss has been identified as one of the most significant limiting factors in the recovery of Chinook and other salmon in the Skagit Basin (SWC 2005, Beamer et al. 2005, Smith no date). Chinook and other salmon using the estuary are all fighting for the same limited resources and the result is direct loss of fish due to predation, starvation, and lack of fitness for

the ocean phase of their lives. Restoration actions in the Skagit River tidal delta have been linked to increased rearing capacity for Chinook salmon as well as system-wide positive responses (Greene and Beamer 2011). Researchers estimate that the delta and estuary are only at about 10 percent of the total goal of restored area (Greene and Beamer 2011).

The Skagit River Delta area is a critical waterfowl wintering area due to the mild climate and available habitats, including marshes, intertidal flats, and adjacent agricultural fields. It is an important stopping point for migratory birds along the Pacific Flyway such as trumpeter swans and Wrangel Island snow geese. At least 190 species of birds have been documented in the project area (WDFW 2006). These birds including raptors, waterfowl, shorebirds, game birds, and songbirds. Wading birds, such as great blue heron, use the Skagit Basin as either over-wintering grounds or as permanent residents, utilize the estuary areas year round. Shorebirds use flooded agricultural fields and estuaries mainly as a critical feeding station during their long migration and as over-wintering habitat. Dunlin and black bellied plover winter in the Skagit delta. Although a large number and variety of birds use the area, this broad delta could be substantially more productive in its restored condition with native plants and greater areas of distributary channels in the nearshore zone to support significantly greater populations of birds.

The proposed restoration at the North Fork Skagit River Delta is located between the former Dry Slough inlet and the western levee system's end near Rawlins Road. The proposed project reconnects and restores wetlands on both banks of the river, restores natural shoreline and provides 256 acres of scarce tidal freshwater marsh on both north and south sides of the river. These habitat types are important to all riverine species, such as salmon and other fish species, resident and migratory waterfowl, and aquatic-oriented mammals such as river otters, beavers, and mink because of the high productivity of aquatic insects, which are an important food source for fish and waterfowl, and dense low-growing vegetation that supports small mammals. Tidal zones act as a transitional mixing zone for in- and out-migrating fish, and provide rearing and nesting habitat for migrating shorebirds and resident waterfowl.

6.1.3.2 *Site-Specific Goals & Objectives*

The goal of this project includes restoration of estuarine emergent marsh, scrub-shrub, and forested floodplain along the North Fork Skagit River to improve connectivity and reduce fragmentation along the channel. The following are the site-specific objectives for the North Fork Skagit River Delta, and all are applicable for the 50-year period of analysis:

- Reconnect and restore lost floodplain habitats including channel meander zone, shoreline complexity, and shaded refuge habitat in the North Fork Skagit River Delta.
- Reconnect and restore lost tidally influenced areas including estuarine and freshwater tidal wetlands as well as tidal channels in the North Fork Skagit River Delta.

- Re-establish foraging habitat in the North Fork Skagit River Delta for Great Blue Herons, and improve resting and foraging tidal flat habitats for large flocks of waterfowl and migratory shorebirds of the Pacific Flyway.
- Improve aquatic habitat connectivity between lower river systems and upstream habitat networks of the Skagit River.
- Restore a more natural riparian corridor along the North Fork Skagit River Delta.

6.1.3.3 *Site-Specific Constraints*

There are several site-specific constraints that a recommended plan would attempt to avoid during formulation. The following are a list of notable issues that constrain the plan formulation:

- The project cannot prevent the use of Best Road Bridge, as this bridge is a primary access to Fir Island, connecting it with Interstate 5 and State Route 20.
- The project will avoid one known HTRW site located on the north portion of the river.
- The Swinomish Tribe and Upper Skagit Tribe are federally recognized tribal nations that have treaty-reserved fishing, hunting, and gathering rights in the project area. Negative effects to tribal interests will be avoided to the extent practical.

6.1.3.4 *Initial Plan Formulation*

Previously existing plans for this restoration site were considered during the Study Team's initial plan formulation process. Elements found in the 2005 Skagit Chinook Recovery Plan are included in the Nearshore Study design alternative. While the prior plan's goals and objectives were focused on the recovery of a single species of salmon, the plan dovetailed very well into the Nearshore study's goals and objectives to provide a holistic restoration of substantial areas of aquatic nearshore habitats. The Corps used the preliminary Chinook Recovery Plan alternative and project footprint as a starting point for initial plan formulation activities.

As described in section 4.1, 21 management measures were identified for implementation across Puget Sound. Management measures identified for this study are detailed in "Management Measures for Protecting and Restoring Puget Sound Nearshore" (Management Measures Technical Report, Clancy et al. 2009). Structural measures (e.g., armor removal, dike removal, channel rehabilitation, etc.) and non-structural measures (invasive species control, physical exclusion, public education, etc.) were identified and evaluated. A summary of the 21 management measures and their relationships to nearshore ecosystem processes are shown in Table 4-1. As described in section 4.1, the 21 management measures were classified into three groups: restorative measures, prerequisite measures, and protective measures. Of the 21 management measures originally identified, nine management measures were carried forward in the formulation of alternative plans. These measures exert long-lasting effects on ecosystem processes and will often provide the best opportunity of achieving complete restoration of processes, directly meeting the planning objectives of this study.

Based on the screening described in section 4.1, the study team evaluated which of the nine remaining management measures could be implemented at the North Fork Skagit site. The team qualitatively determined whether the identified measures met the site-specific planning objectives and generally avoided site-specific planning constraints. The following five management measures were carried forward for evaluation at this site:

- Armor removal for streambank restoration and reconnecting floodplain habitat
- Dike removal or modification for floodplain freshwater marsh restoration
- Channel rehabilitation or creation for side channel restoration and floodplain reconnection
- Riparian revegetation for shading, nutrient inputs, and complexity of bank habitat (non-structural measure)
- Setback levees for floodplain reconnection and side channel development

The five management measures carried forward after screening were combined to form a number of viable alternatives that attempted to meet objectives and avoid constraints. The size and scale of measures were identified to take advantage of existing topography, using the existing flood risk features in the basin where applicable and tying into the existing forested habitat in the project area. Measures proposed on the southern shoreline that impact the Best Road Bridge were screened out, as this bridge is a primary access to Fir Island, connecting it with Interstate 5 and State Route 20. In addition, the existing bridge alignment does not impede ecosystem processes, and removal or realignment would have minimal benefits and actually have short-term impacts to the riparian corridor. Alternatives were also designed to avoid impacts to a storm water detention area for the Best and Fir Roads. Finally, due to the nature of the area's flat floodplain morphology, the alternatives required inclusion of a flood risk measure to prevent extensive flooding beyond the project area, avoid inducing damage to structures, and avert flood impacts to the road network. Based on the initial plan formulation, evaluation, and screening activities summarized above, one alternative was identified that meets the study objectives, avoids constraints, and restores critical habitat for nationally significant resources.

6.1.3.5 *Summary of Proposed Action*

The restoration proposal includes actions on both the south and north banks of the North Fork Skagit River. The current alternative takes advantage of existing infrastructure and topography to minimize new work and therefore, project costs. An exception would be the eastern most portion of the alternative, which is separable from the primary project features and will require additional analysis.

Approximately 13,000 feet of levee along the south bank will be lowered to allow creation of a tidal channel network on the south side of the river. In addition to lowering levees, a new levee will be constructed along a road alignment (Rawlins Road) to promote riverine and tidal exchange in the project area, to isolate the restoration area from surrounding agriculture, and to

maintain existing levels of flood risk management to surrounding land and infrastructure, including 208 structures on Fir Island. This setback levee alignment follows the embankment for Rawlins Road and ties into the coastal dike system.

On the north bank of the river, approximately 3,140 feet of shore armoring will be lowered. Site topography and an upland levee provide site boundaries and flood risk management without the need for a new levee on the river's north side; the northern boundary ties into high ground and the existing Diking District 9 levee. Planned breaches in the lowered levee and in the area of armor removal as well as excavated channels on both banks of the river will allow for water to access the newly restored floodplain. Replanting lowered levees will restore a natural riparian corridor along the river from 1,700 feet upstream of the Best Road Bridge to the end of the current south bank levee system on Fir Island.

The proposal includes levee lowering and excavation of new tidal channels on the eastern portion of the project footprint. In PED, additional hydraulic and hydrologic modeling for the vicinity of the Best Road Bridge will determine whether project designs will be refined for this area or whether the area will be removed from the project footprint. This area is separated from the rest of the project area by the bridge. Potential removal of this portion of the project from the proposal would not impact the remaining design and would result in comparable reductions to both area restored and total project cost. Figure 6-8 depicts the key design elements at North Fork Skagit River Delta.

6.1.3.6 *Separable Elements Analysis*

To help inform initial plan formulation and analysis, a qualitative evaluation of three different geographical elements of the North Fork Skagit site was completed. The three areas evaluated included: (1) South – West Area, (2) South – East Area, and (3) North Area (Figure 6-7).

A summary of the results of this qualitative evaluation are included below:

Summary of Costs and Benefits:

	South – West Area	**South – East Area**	**North Area**
% of Total Project Cost	74%	18%	8%
% of Benefits	67%	8%	25%

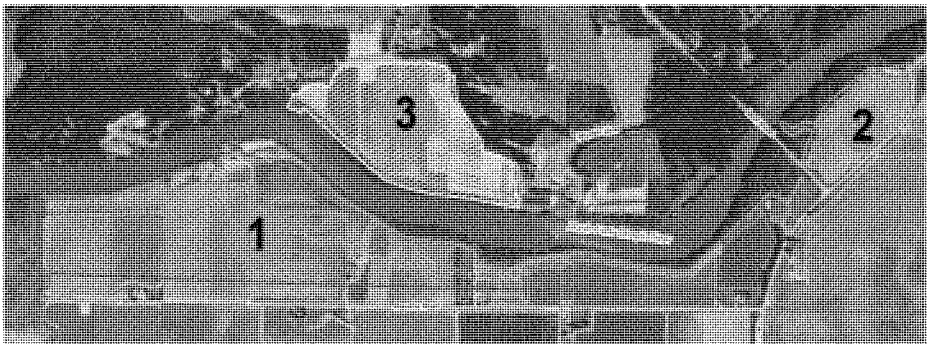
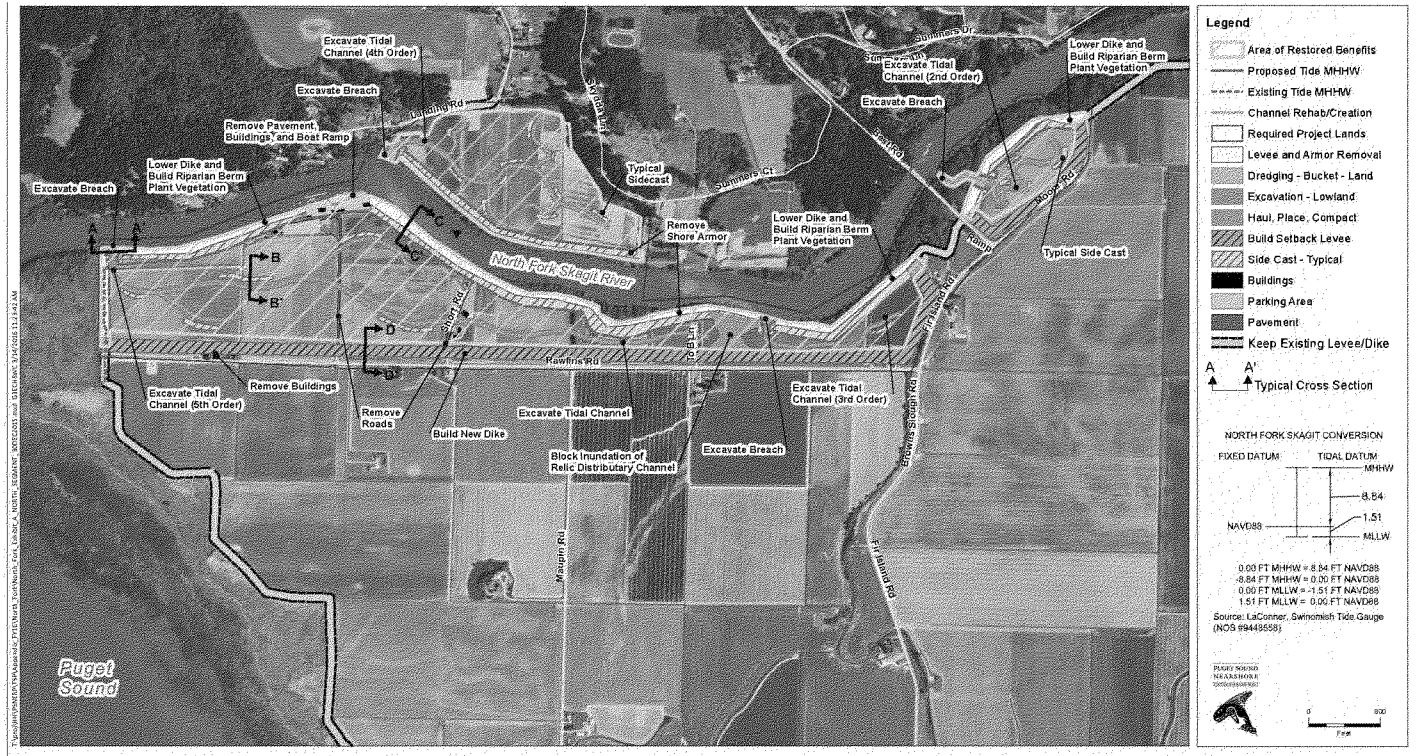


Figure 6-7. Geographical Elements of North Fork Skagit Site.

The South – West Area of this site provides the majority of ecosystem restoration benefits and associated costs. Inclusion of the North Area provides one-quarter of the ecosystem restoration benefits at this site for a marginal percentage of total project cost. Restoration of both banks of the river (south area plus north area; left and right riverbanks) is critical to achieve benefits at this site. Armor removal provides habitat capacity for juvenile Chinook rearing, and each additional foot of armor removal supports more unique fish as they distribute along the left and right riverbanks; therefore, it is important to restore both banks of the river, and to add as much shoreline length and Chinook salmon habitat capacity as possible. In addition, creation of tributary channels provides rearing habitat for juvenile Coho salmon and each additional foot of tributary supports additional fish as they distribute along the channels; therefore, it is important to create and accelerate the development of tributary channels along both banks of the river to add as much tributary length and Coho salmon habitat capacity as possible. Finally, creation of tributary channels provides foraging habitat for Great Blue Herons as well as beaver, mink, and muskrat habitat. The aquatic-oriented mammals are likely to set up residence on only one side of the North Fork of the Skagit River, so restoration along both banks of the river will benefit additional individuals and family groups expanding the regional populations.

As described above, additional hydraulic and hydrologic modeling for the vicinity of the Best Road Bridge (South – East Area) will determine whether project designs will be refined or whether the area will be removed from the project footprint. The modeling is to support the final design of levee elevations and alignment, channel and breach dimensions and protection of bridge abutments as well as to confirm the extent of benefits for the restored area. This area is separated from the rest of the project area by the bridge. Potential removal of this portion from the proposal would not affect the remaining design and would result in comparable reductions to both area restored and total project cost.



ORTHO_2013_NAIP_WASHINGTON

Site Name: North Fork Skagit River Delta [Area of Restored Benefits]

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Figure 6-8. North Fork Skagit River Delta

6.1.3.7 *Hydrology & Hydraulics*

Flood Limits: The study used available data to determine the extent of the potential floodplain limits. The hydraulics and hydrology for the restoration site were evaluated using an area of potential hydraulic effects specific to the restoration requirements for each particular site. The limits of the area for this site were established using 1% AEP base flood elevations derived from a combination of FEMA Flood Insurance Rate Maps and Flood Insurance Studies as well as Corps base flood elevation determinations. According to the FEMA flood insurance mapping for unincorporated areas of Skagit County, community 530151 (revised 1985), the entire site lies well within the 1% AEP (100-year) floodplain and away from floodplain boundaries.

Modeling: This part of the North Fork Skagit River is tidally influenced. Hydraulic modeling is required to support the final design levee elevations and alignments, channel and breach dimensions and protection of bridge abutments for the Best Road Bridge. Modeling will also confirm the extent of benefits for the restored areas as well as the expected evolution of the project through sedimentation. Additional modeling during PED will include consideration of tidal influences since the amount of increased tidal prism is required to ensure a design of the breach openings and tidal channel dimensions that minimizes maintenance costs. An existing river flow model has been developed for the Skagit River as part of the Skagit GI and can be used to make preliminary estimates of the with-project changes in riverine hydraulics in the project vicinity. A three-dimensional estuarine and coastal ocean model, including sedimentation effects, has been developed at the Pacific Northwest National Laboratory (PNNL) with support from the Skagit Watershed Council and the Skagit River System Corporative. This model has been successfully used to evaluate restoration projects in the Skagit watershed and is available to use during the project design phase. Hydraulic modeling including coastal and sedimentation analyses for the North Fork Skagit site is discussed in Appendix B Section 3-2 and summarized in Appendix B Section 3-21.

Existing Levee System: On the south side of the North Fork Skagit River, Skagit Diking District 22 is a connected levee system that, combined with a system of sea dikes, provides flood risk management to all of Fir Island (Figure 6-9). Fir Island is a flat low-lying part of the Skagit Delta that relies on agriculture and tourism, including fishing, wildlife viewing, as well as popular and economically significant tulip and daffodil festivals. The Diking District 22 levee system has a 2% AEP (50-year) level of residual risk based on levee screening conducted by the Corps. This levee system is part of the Corps PL84-99 Program and received a Levee Safety Action Classification (LSAC) of 4 – low risk in the 2014 Levee Screening Program fact sheet.

Skagit Diking Districts 1 and 9, combined with outcrops of high ground, protect areas on the north side of the North Fork Skagit River from flooding. Diking District 9 is adjacent to the project site and has a level of residual risk from overtopping of over 0.2% AEP (500-years). No alterations are proposed for the Diking District 9 levee.

To confirm the need for a setback levee on the southern boundary of this site (versus acquisition of property or easements), the study team examined the effects of induced flooding; the estimated value of real estate interests that may be susceptible to induced flooding, as well as the estimated costs for construction of levees.

Approximately 6,700 acres of land – most of Fir Island – will be at risk from riverine flooding if the existing levee is removed at the North Fork Skagit River Delta site. Preliminary real estate evaluation indicates the value of the area protected by the proposed levee is approximately $94 million. The estimated cost of the levee is $32 million. Acquisition of affected real estate would be significantly more costly than building the proposed levee. Because of this cost comparison and because the new levee would promote the establishment of riparian processes and isolates the restoration area from agricultural runoff, the study team determined that construction of the levee at this site is the preferred method to achieve the ecosystem restoration benefits at the North Fork Skagit River Delta.

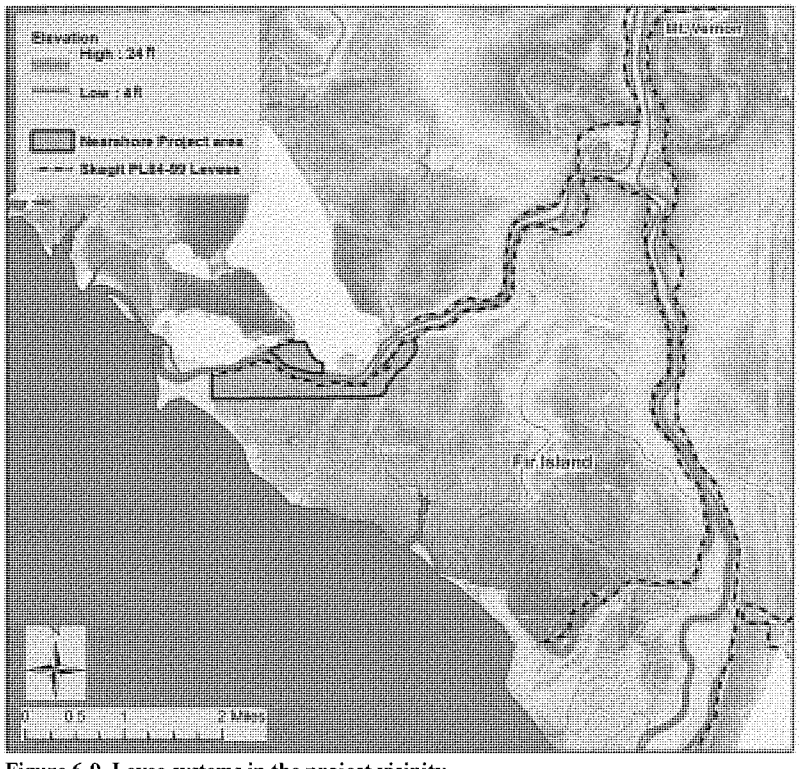


Figure 6-9. Levee systems in the project vicinity

Table 6-6. Induced flooding estimates from North Fork Skagit River Delta project

Source of Flooding	Current Level of Residual Risk	Estimated Level of Residual Risk without Levee	Estimated Area Protected by Levee (Acres)	Real Estate Value of Area Protected by Levee ($1,000s)	Cost of Levee ($1,000s)
Riverine	2% AEP (50-year)	20% -50% AEP (2-5 years)	6,700	$93,800	$31,738

6.1.3.8 *Operations & Maintenance*

Operations and maintenance costs for the North Fork Skagit site are related to maintenance and repair of levees as well as maintenance of plantings and removal of invasive plant species in the project area. The annual OMRR&R estimate is approximately $36,000 per year; OMRR&R activities are a non-Federal sponsor responsibility.

6.1.3.9 *Public Review*

Site-specific comments received during public review were related primarily to concerns from the agricultural community regarding conversion of farmland for ecosystem restoration. The Corps and non-Federal sponsor will continue to coordinate with landowners and stakeholders as the design progresses.

6.1.3.10 *Risk & Uncertainty*

The study team has used a risk-based strategy in their approach to formulating the project from the early stages of the study. Key risks or uncertainties associated with this site include the following, along with the strategy to reduce risk as the study continues:

Earthwork Quantities

Risk and Cause: Earthwork quantities for setback levees, abutments, and other measures were determined based on available LiDAR data. In addition, no soil investigations have been done on site to characterize possible settlement of the setback levee.
Risk Management: Additional survey data, LiDAR, and soils information will be obtained during the PED phase. Additional hydraulic modeling and geotechnical analysis will be conducted to refine the size and scale of setback levees and levee alignment near the Best Road Bridge. PED costs include estimates for both obtaining the required data and performing necessary engineering analyses. The CSRA for the project has identified risks associated with the variability in existing survey/ LiDAR data with varying resolution as well as uncertainty in future settlement of the setback levee. Cost contingencies reflect the uncertainty in quantities of material required for construction.

6.1.3.11 *Ecosystem Restoration Benefits*

As Figure 6-8 depicts, this site restores several processes including sediment transport, freshwater input, tidal exchange, channel migration, marsh accretion, overbank deposition, and natural levee formation that occurs when riverbanks are allowed to overflow naturally and deliver overbank deposition. Restoration of this site provides benefits to ESA critical habitat for Chinook salmon and bull trout as well as direct benefits to bald eagles, waterfowl, western toads, salmon, bull trout, and steelhead. Additional benefits include the following:

- Reconnects and restores 256 acres of scarce tidal freshwater marsh and lost floodplain habitats, including restoration of highly productive tidal freshwater wetland habitats that support biodiversity and provide connectivity between land and sea (meets site-specific planning objective #1).
- Re-establishes and improves shorebird foraging and resting tidal flat habitats for large flocks of Dunlin, Great Blue Herons and other marine birds and migratory shorebirds, which historically existed and could increase bird populations in health and numbers if restored (meets site-specific planning objective #2).
- Improves nearshore and adjacent uplands linkages for exchange of water, sediments, nutrients, woody debris, and freshwater-dependent mammals that cross both habitat types (meets site-specific planning objective #3).
- Restores a more natural riparian corridor by removing 16,140 linear feet of riprap from riverbank, providing juvenile salmon rearing habitat/benefits, tidal wetlands, and small tributaries (meets site-specific planning objective #4).
- Restores large river delta that provides valuable nursery habitat for juvenile threatened salmon species, increasing survival and supporting Puget Sound population recovery.

6.1.3.12 *Significance*

- Restores floodplain and tidal connectivity in the estuary of the Skagit River, the largest and most productive river in Puget Sound
- Included in the Puget Sound Chinook Salmon Federal Recovery Plan
- Provides habitat for Pacific Northwest indigenous species on the lower North Fork Skagit River, where limited restoration opportunities and estuary habitats exist
- Benefits State of Washington Priority Habitats and Species categories of wintering waterfowl, bald eagle, and western toad

6.1.3.13 *Site Specific Project Impacts*

Removal of 15,680 feet of levee and associated armoring for restoration of 256 acres of tidal freshwater wetlands/floodplain habitat will achieve long-term benefits that are discussed in the previous section (*Ecosystem Restoration Benefits*), but will also have short-term construction impacts listed below necessary to achieve the benefits.

Physical Environment: Nearshore Processes and Structure

Processes, Physiographic Characteristics, Oceanography, and Sedimentation and Erosion: These resources would all be positively effected as described in the previous section (*Ecosystem Restoration Benefits*) primarily by reconnecting a portion of the North Fork Skagit River with its floodplain.

HTRW: A Phase 1 Environmental Site Assessment was started in 2010 and completed in 2015 by members of the USFWS and the USACE, Seattle District (See Engineering Appendix). The records search did not identify any known or suspected hazardous substance releases in the project footprint. The Washington State Department of Ecology lists one state cleanup site in the vicinity of the project footprint, 0.4 miles north of the river on the east side of Best Road. It is not expected to affect or be affected by any Corps actions due to its distance from the proposed project and the lack of a hydraulic connection to the site. Anecdotal evidence along with historical observation indicated the possibility of a former Skagit County garbage dump to the west of Brown's Slough Road (now called Fir Island Rd). Skagit County records show no historical landfills on Fir Island. If additional information arises during the course of the project that suggests there are HTRW concerns within the project area, the suspected HTRW area will be avoided. Please refer to Appendix B (Engineering) for the complete Phase 1 assessment.

Water Quality: Water quality would experience pulses of turbidity during breaching of levees and excavation of channels along both banks of the river; however all work would be done using best management practices during construction including isolation devices such as cofferdams or equivalent, silt curtains, excavating channels prior to complete breaching of levees, and timing work during low flows to prevent turbidity from affecting the aquatic environment. The need for isolation devices at this site will be evaluated during PED. Installation of water isolation devices may cause pulses of turbidity, but the duration of effect would only be a matter of hours and for an area not likely to exceed an estimate of 1,000 feet based on velocity of flow in the rivers. Long-term water quality conditions would improve by allowing attenuation of sediments and pollutants from the river into reconnected floodplain wetlands.

Green House Gases: Construction machinery was estimated to have GHG emissions of 5,992 tons of CO^2 based on types of machinery that would be used and estimated duration of construction.

Underwater Noise: Machinery would may cause underwater noise in the freshwater environment during excavation and armor removal. However, in-water work would occur during low flows when sensitive species are least likely to be present.

Biological Environment: Nearshore Functions

Vegetation: Temporary access routes can occur via the existing system of county and farm access roads. Vegetation falling within the footprint of areas necessary for excavation, armor removal, building a setback levee, and staging will likely need to be removed. These areas will

be determined during the PED phase. Little vegetation exists in the proposed levee setback area. Areas free of trees and other native vegetation will be utilized to the extent practicable. Replanting of disturbed areas would occur following construction. Turbidity from construction would not be substantial enough to harm this aquatic vegetation. No eelgrass or kelp occur at or downstream from the project site.

Shellfish: No shellfish populations occur at or downstream from the project footprint. For other macroinvertebrates within the project site, actions would have the short-term impact of disrupting or destroying benthic and epibenthic invertebrates. Once the stressors are gone, invertebrate colonization would follow a pattern of succession, with near complete recovery in one to three years (Hueckel and Buckley 1987, Martin 2012 pers. comm.).

Fishes: This site in the lower North Fork Skagit River serves as a migration corridor for all five species of Pacific salmon plus steelhead, cutthroat, bull trout, and Dolly Varden. Negative effects would come from construction activities causing 1) increases in turbidity from excavation of fill, and 2) vibration associated with large equipment operation for excavation. Elevated levels of turbidity could cause a behavioral response to flee or delay migration, but would not be substantial enough to cause physiological damage. Working within the designated work window of 15 June through 31 August when fish are less likely to be present and during low tides would minimize effects of turbidity on fish.

Birds: This area hosts bald eagles and over-wintering waterfowl concentrations. Construction activity including armoring removal, channel excavation, and hauling off large amounts of material would cause temporary disturbances to bird communities due to noise and the presence of heavy equipment, likely causing a behavioral response to flee the area. No long-term impacts to bird populations are anticipated.

Mammals: No impacts to marine mammals are anticipated as the site is well upstream of marine waters. Impacts to other aquatic mammals like river otter, beavers, and muskrat would derive from noise and turbidity associated with construction. Effects would likely cause a response to flee the area, but would not have long-term impacts to populations in the project area.

Rare, Threatened, or Endangered Species: Impacts to ESA listed species are similar to those described for fish, birds, and mammals. Through coordination with NMFS and USFWS, the ESA-listed species and critical habitat that the Corps consulted on include the following determinations: Likely to Adversely Affect bull trout, Puget Sound Chinook salmon, and Puget Sound steelhead; Not Likely to Adversely Affect critical habitat for these three salmonids; and Not Likely to Adversely Affect Southern Resident killer whale or its critical habitat. No marbled murrelet or spotted owl nests occur within disturbance range of the site (see Appendix J).

Cultural Resources

The North Fork Skagit River Delta contains five previously recorded archaeological sites, and one archaeological district located either within or directly adjacent to the restoration site. These sites include a pre-contact habitation site that is a contributing element to Fishtown

Archaeological District located adjacent to the restoration site with the remainder identified as shell middens. In terms of the built environment the North Fork Skagit River Delta site contains an unevaluated historic granary, the unevaluated Skagit levee, and an historic farming complex that contains a barn listed on the Washington Heritage Barn Register Table 6-7 listed the known cultural resources located in or adjacent to the North Fork Skagit River Delta site and the potential effect based on the current project design

The Corps has prepared a PA outlining the Section 106 process that will be followed in PED (Appendix D). The PA is the mechanism that allows for Section 106 compliance as long as the PA situations are implemented in PED. The PA includes which Section 106 tasks need to occur prior to construction (e.g. fieldwork), how Section 106 consultation will occur, how determinations of eligibility will be made, how findings of no adverse effect will be determined, how findings of adverse effects will be made, and how the PA will be implemented, and a dispute resolution procedure. In addition, the PA provides for a variety of treatment measures that can be used for mitigation of an adverse effect (See Appendix E of the PA). The treatment measures are standard types of mitigation actions used for adverse effects and the costs of these treatment measures have been taken into account during cost estimation for this project.

Table 6-7 North Fork Skagit River Delta Archaeological Sites

North Fork Skagit River Delta Archaeological Sites				
Site Number*	**Description**	**NRHP Eligibility**	**Location**	**Potential Effect to Resource Based on Current Design****
Fishtown Archaeologic	*Sqwikwikwab,* ethnohistoric village and	Eligible	Adjacent to project area	Appears that it will be affected based on current project design
45SK34	Pre-contact habitation site	Eligible: Part of the archaeological	Extends into project area	Appears that it will be affected based on current project design
45SK35	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
45SK78	Pre-contact shell midden site	Unevaluated	Just outside of project area	Appears that there will be no effect based on current project design
45SK80	Cave with pile of shell	Unevaluated	Adjacent to project area	Appears that there will be no effect based on current project design
45SK87	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
North Fork Skagit River Delta Structures				
Description*	**Date Constructed**	**NRHP Eligibility**	**Location**	**Potential Effect to Resouree Based on Current Design****
North Fork Skagit River Levee	1935	Not Evalnated	In project area	Appears that it will be affected based on current project design
45SK337	Summers Farm Barn 1885	Washington Historic Barn Register	In project area	Appears that it will be affected based on current project design

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

**Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change.

Socio-Economic Resources and Human Environment

Land Use: As described in section 5.4.1, the change in land use at the North Fork site will convert only 5 acres of prime or important farmland according to NRCS consultation. Which is only .005 percent of total farmland in Skagit County. Given this small fraction, impacts to farmland would be minor and insignificant. The individual farmer(s) would be compensated for their loss during the purchasing agreement with the local sponsor and the loss of crop production would likely be absorbed by other nearby farms. Some properties may already have easements, or may involve property acquisition by the local sponsor; minor land use changes are the only anticipated long-term impact from this project. Restoration of tidal wetlands has potential for displacement or substitution of recreation opportunities associated with this site: Blake's Marina, which consists of a 120-foot day-use dock, a 500-foot overnight-use dock and a boat ramp would be removed. The lower Skagit River has other nearby launch sites that would absorb the low volume of vessel traffic.

Commercial Fisheries: No commercial fisheries or aquaculture are anticipated to be negatively affected by this project. Restoration of tidal wetlands in the Skagit River estuaries would support fish and wildlife species by creating additional habitat for foraging and refuge.

Recreation: Temporary impacts to recreation may occur due to limited access during construction. Blake's Marina would be removed and relocated to another nearby launch site in the lower Skagit River. Recreation such as increased bird watching opportunities may increase long-term as more wetland species use the area; however, benefits to recreation are incidental to the project as there will be no expenditure toward increased access or recreation features.

Transportation: No effects to transportation are anticipated; only local roads occur at this site and the bridge that crosses the river at this location will not be affected.

Public Safety: New constructed levees will maintain the same level of flood protection as the levee it is replacing; new levees would protect public or private property from inundation that could result from the restoration work.

6.1.3.14 *Site Summary Statistics*

- Acres Restored: 256 acres of scarce tidal freshwater marsh
- New tidal channel excavation for fish habitat and acceleration of site benefits: 19,617 linear feet
- Removes 16,140 linear feet of riprap from riverbank anticipated to increase rearing capacity of juvenile Chinook by more than 500% (Beamer and Henderson 1998)
- Total Project Cost: $99.3 M (refer to Table 6-8 for cost summary)

Table 6-8. Project Cost Summary – North Fork Skagit River

Project Cost Component	Project First Cost ($1,000s; October 2015 price level)
Construction and Real Estate	
Construction Costs	$62,497
Real Estate Costs (including relocations)	$13,922
Planning, Engineering and Design (PED)	$14,286
Construction Management (CM)	$6,167
Monitoring	$379
Adaptive Management	$2,050
Total Estimated First Cost	**$99,299**
Amortized Cost (3.125% discount rate[1])	$4,070
OMRR&R[2]	$36
Total Average Annual Cost (AAC)	$4,106
Total Benefits (AAHU)	53.7
Total AAC / AAHU	**$76**

[1] Includes interest during construction (IDC). [2] Operations, maintenance, repair, replacement & rehabilitation (non-Federal sponsor responsibility)

6.2 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 B) 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. The studies are summarized in Appendix B, Sections 1-21, 2-21, and 3-21. They include the following:

- Property and utility investigations: Parcel ownership, property boundaries and utility survey - needed to confirm acquisition requirements and refine real estate and relocation costs,
- Data collection: Topography, bathymetry, tidal gauging and soils testing - needed to support civil and structural design as well as hydraulic and hydrologic analyses,
- Hydraulic and hydrologic analysis and modeling: Riverine, coastal and sedimentation studies - needed to optimize design features, refine construction cost estimates, confirm areas of environmental benefits, identify areas of induced flooding and predict/minimize actions for O&M.
- Geotechnical analyses: Foundation design, analysis of settlement and seepage of project features and identification of disposal and borrow sites- needed to finalize design features and refine cost estimates.
- Structural analyses: Design of bridge deck and supporting structure for gravity, wind and seismic effects – Needed to finalize bridge designs and refine cost estimates.

- Civil Engineering analyses: Pavement design including traffic study for roadways and approaches – Needed to finalize designs and refine costs estimates.
- Cultural resources investigations: Survey for archaeological and historic resources in areas proposed for excavation – needed for Section 106 compliance and to finalize project footprint.
- Phase II Environmental Site Assessment: (Nooksack Only), Assessment of historic fills for contaminants – needed to finalize project footprint.

In developing the cost estimate for the feasibility study, specific borrow sources and disposal areas were identified to determine haul distances. These locations will be confirmed during PED. For the Nooksack and North Fork sites, multiple borrow sources are located within 30 miles of the sites along the Interstate highway corridor. A haul distance of 30 miles was used. At Duckabush, which is in a more remote area, the haul distance for borrow was estimated at 60 miles either to the North at Port Angeles or to the South at Tumwater.

The study team will continue to develop the scope, schedule, and budget for PED activities as the study continues. Prior to commencement of the PED phase, team members will participate in a technical scoping workshop to confirm scope and cost of the studies summarized above, as well as potential scaling and sequencing of proposed studies.

6.3 Real Estate Considerations

The recommended plan includes three sites that have a total real estate footprint of 2,480 acres: Duckabush River Estuary (58 acres), Nooksack River Delta (2,080 acres), and North Fork Skagit River Delta (342 acres). Based on the current project footprints, approximately 220 landowners would be affected, with the total estimated land values estimated at $30,989,000.

Due to the conceptual level of detail of current project designs, land values were estimated based on fee value. As project designs are refined and additional data is gathered during PED, specific real estate interests will be identified and assigned to the project lands as applicable. At this time, standard real estate interests anticipated for the project lands include Fee, Perpetual Road Easement, Temporary Work Area Easement, Perpetual Channel Improvement Easement, and Perpetual Flowage Easement *(Occasional Flooding)*. It is unknown whether any Non-Standard Estates will be required for this project; the need for any Non-Standard Estates will be identified during PED.

In addition, tribal lands and interests will be further defined during the PED phase. Informational conversations between the Corps, Non-Federal Sponsor, and the Lummi Indian Tribe are underway, as the Lummi Indian Tribe has landownership interests at the Nooksack River Delta site. The Lummi Tribe continues to be supportive of the proposed restoration project.

Utility/Facility Relocation items as well as Uniform Relocation Assistance (PL 91-646) requirements will be further defined during PED. An initial assessment of utilities that could be impacted include electrical, water/sewer, telecommunications, roads, and bridges. Preliminary

Uniform Relocation Assistance (PL 91-646) assumptions and scope resulting from the project activities have also been identified and apply primarily to the Nooksack River Delta and North Fork Skagit River Delta sites. See Appendix C (Real Estate Plan) for additional real estate detail and associated maps.

6.4 Monitoring and Adaptive Management

The Nearshore Study's Monitoring and Adaptive Management Plan (Monitoring Plan; Appendix E) is a framework for development of site-specific plans based on the restoration strategy that is primary for the site—river delta, barrier embayment, coastal inlet, or beach. The goals of the monitoring plan are to determine whether the management measures applied to the sites are producing the desired effects and to determine whether corrective action is needed to improve effectiveness. Processes are inherently difficult to measure and quantify directly, and on their own do not tell the full story of restoration success. Therefore, structural and functional responses typically are monitored as indicators of restored processes. Each landform type has predicted ecological outcomes that would indicate the performance of a restoration site. Performance is documented through an evaluation of monitoring results. Site-specific objectives were developed for each site in the Recommended Plan. Even the most strategically planned restoration actions can yield unexpected results. Monitoring documents and diagnoses these results especially in the early, formative stages of a project and provides information useful for taking corrective action. In this way, it reduces the risk of failure and enables effective, responsive management of restoration actions.

The site-specific monitoring plans (Annexes A, B, and C to Appendix E) contain metrics that must be monitored to evaluate whether they follow a predicted response. The performance target for each response is developed from the best scientific understanding of how the system will evolve following restoration site implementation. Metrics for each indicator are selected to provide enough information to track an indicator through its predicted response, as well as to explain why when performance reflected by an indicator is or is not developing as predicted. Each indicator in the Monitoring and Adaptive Management Plan is presented in Appendix E along with its predicted response and the metrics required to monitor it. The site-specific monitoring plans contain metrics and performance targets that are tied to evaluation of project objectives. These performance targets, if not met, will trigger an adaptive management action. The Corps will implement the Monitoring Plan to provide the necessary post-construction monitoring that will verify implementation and effectiveness of the management measures.

The complete site-specific monitoring plans are presented as Annexes A, B, and C of Appendix E after the overall framework. Examples of monitoring metrics include increased tidal prism, increased riverbank complexity, wetland development, increased soil salinity, and increased ground coverage of native vegetation. Some of the parameters require only a few years of monitoring to determine whether the management measures have been successful, while other processes can take many years to decades to develop and therefore require monitoring up to and

perhaps beyond the cost-shared period of 10 years. Each monitoring metric has recommended adaptive management measures in cases where the performance target is not met. Costs for monitoring and adaptive management based on current designs for each site of the Recommended Plan are as follows:

- Duckabush Estuary – $205,000 Monitoring; $2,151,000 Adaptive Management
- Nooksack River Delta – $506,000 Monitoring; $1,106,000 Adaptive Management
- North Fork Skagit River Delta – $379,000 Monitoring; $2,050,000 Adaptive Management

While the Ecosystem Outputs Model (Appendix G) quantified site-specific characteristics for how they met overall project planning objectives, the Monitoring Plan does not revisit these broad parameters from a Sound-wide analysis. Instead, the three Annexes of the Monitoring Plan take the site-specific restoration objectives for each project site and outline which parameters can be measured to determine levels of project success. No further validation or investigation for the Ecosystem Output Model is planned regarding meeting objectives.

6.5 Environmental Operating Principles and Campaign Plan

The Corps has reaffirmed its long-standing commitment to environmental conservation by formalizing a set of Environmental Operating Principles (EOPs) applicable to decision-making in all programs. The EOPs outline the Corps' role and responsibility to sustainably use and restore our natural resources in a world that is complex and changing. The recommended plan meets the intent of the EOPs.

The Corps' Campaign Plan includes specific goals and objectives to deliver integrated, sustainable, water resources solutions. This project primarily supports the Corps' Campaign Plan Goals 2 and 4. These goals include transformation of the Civil Works process to deliver enduring and essential water resource solutions using effective transformation strategies as well as build resilient people, teams, systems, and processes to sustain a diverse culture of collaboration, innovation, and participation to shape and deliver strategic solutions. The project meets the intent of these Campaign Plan goals.

6.6 Consideration of Climate Change

In the Pacific Northwest, climatic changes are expected to trend towards warmer, wetter winters and hotter, drier summers. Models developed by the University of Washington Climate Impacts Group (CIG) predict the following scenarios for Pacific Northwest temperatures in the 21st century (as compared to the 20th):

- The rate of change of temperature will be greater,
- The total amount of temperature change will be greater,
- All seasons will be warmer, especially in the months of June through August,

- The average annual temperature will likely exceed the range of average annual temperatures during the 20th century, and
- Changes in nearshore sea surface temperatures, though smaller than on land, are likely to substantially exceed inter-annual variability.

Existing seasonal patterns of rainfall may shift, with a decrease in summer and an increase in winter. Average annual precipitation will likely stay within the range of 20th century annual average precipitation (Climate Impacts Group 2008). Most of this precipitation is expected to fall as rain and not snow, causing lower flows in the summer (due to lack of snow melt) and higher flows in the winters (due to increased rain) in the many rivers and streams that empty into Puget Sound. There is a strong consensus among climate change investigations that future storm events in the region will be more intense and more frequent compared to the recent past (USACE 2015).

In addition to changes in precipitation and air temperatures, predicted estimates for sea level change in Puget Sound range from low estimates of 0.4 feet to high estimates of 6.3 feet between 2015 and 2115 depending on location. This range incorporates slightly higher sea level rises expected in the south Puget Sound around Olympia and Tacoma and slightly lower expected rises in the north Puget Sound around Friday Harbor and Bellingham Bay. More detailed information and analysis on climate change and how it may affect the Puget Sound basin is incorporated in section 3.6 (Future without-Project Conditions).

Proposed restoration at the three sites included in the Recommended Plan concentrates on removing the environmental stressors leading increased natural resiliency of the restored areas to climate change effects. The Engineering Appendix (Appendix B) for these sites address risk of sea level change using low, intermediate, and high scenarios developed for Corps coastal investigations (USACE 2013). Removal of nearshore stressors such as dikes, armoring, and causeways will result in the creation and/or restoration of 2,101 acres of tidally influenced wetlands. With shoreline stressors removed, these wetlands should be able to adjust to changing geomorphic processes associated with changing sea levels; shifting landward, if there is room, as water rises and sediment accretes. These wetlands can function as a buffer from storm surge during short events and provide storage capacity during flooding events. In contrast to the open Washington coast, Puget Sound is primarily fetch limited. To generate wind waves and setup, winds have to be aligned just right and this rarely happens for long periods of time. The tendency is to have short duration coastal events coupled with longer duration riverine flooding. During these short events, some reduction of peak coastal surge can occur since the events may not be long enough for development of a steady state. In the rarer cases of sustained winds, the existence of wetlands may actually increase surge heights, since the surge flows over the rougher underlying land surface.

Wetland habitats will become even more essential to nearshore-dependent species that will be subject to the stress of increased temperature, varying velocities in rivers, and ocean acidification. In addition, the augmented infrastructure, such as replacements of causeways with

wide-span bridges at many of the sites, will better withstand the storm surges and flooding events that are expected to occur in the coming century. Further design iterations will ensure that these structures can withstand the predicted climatic changes and rising seas in the region.

The design approach for sites in the Nearshore Study with respect to SLC during feasibility phase is as follows:

- As detailed in section 3.5.6.2, sites assume a single 100-year intermediate rate of rise scenario (~2 ft) throughout the Nearshore Study. This is also about equal to the 50-year high rate of rise. The project performance is assessed for the other two scenarios.
- Restoration features such as channel excavations are allowed to evolve naturally. No adaptation for SLC is included since the design intent is to remove the stressor and allow the system to evolve naturally regardless of SLC. This is in accordance with the rationale presented in Appendix B, Attachment B, *Applied Geomorphology Guidelines and Hierarchy of Openings*.
- Levees at Nooksack and North Fork Skagit River Deltas are designed for the existing level of residual risk only. Since the levees are subsections of larger river and coastal diking systems, adaptive management for SLC in these systems will need to be considered on a system-wide basis. In the future, depending on the timing of SLC, individual diking districts may decide to either raise entire levee/dike systems or modify flood risk management areas to accommodate coastal change.
- As an example, the Lummi River setback levees, as currently estimated, range in crest elevation from 15 to 20 feet NAVD88. This implies that the most seaward extents of the levees will begin to be overtopped by the base coastal flood by 2078 (about 50 years after construction) for the high rate of rise assumption and by 2155 (about 130 years after construction) for the intermediate level of rise.
- Levee design features such as wide crest widths and shallow side slopes allow for levee raising by others in the future as part of a flood risk management project without impacting restoration benefits. Flood risk reduction is not a component of the PSNERP so no adaptive management SLC costs have been included for levees; however, levees will be designed for overtopping if this is indicated in PED when the final levee crest elevations are refined. Appendix B, the Engineering Appendix, discusses the effects of low and high 100-year SLC scenarios as well as the 100-year intermediate (design) scenario.
- Bridges and roadways at Duckabush and Nooksack are designed so that the low chord of the bridge exceeds the Base Flood Elevation plus the 100-year intermediate level of rise (about equal to the 50-year high level of rise) by three feet to allow for debris passage. Appendix B, the Engineering Appendix, discusses the effects of low and high 100-year SLC scenarios as well as the 100-year intermediate (design) scenario. The effects are primarily related to additional OMRR&R costs for the bridges.
- The cost estimate includes added OMRR&R costs from the high sea level rate of rise assumption in the Cost Schedule Risk Assessments.

6.7 Economic/Cost Summary

Based on March 2016 price levels, the estimated project cost is $451,627,000 (with contingency), which includes monitoring costs of $1,090,000 and adaptive management costs of $5,307,000. In accordance with the cost share provisions in Section 103(c) of the WRDA of 1986, as amended {33 U.S.C. 2213(c)}, the Federal share of the project first cost is estimated to be $293,558,000 and the non-Federal share is estimated to be $158,069,000, which includes a 65% Federal and 35% non-Federal cost-share for restoration features. The non-Federal costs include the value of lands, easements, rights of-way, relocations, and disposal areas (LERRD) estimated to be $161,489,000. The LERRD estimate exceeds the 35% non-Federal cost share for restoration features by $3,420,000 and the value of these excess LERRD may be reimbursed to the non-Federal sponsor subject to the availability of funds. However, this situation is unlikely to be realized because the escalated, fully-funded cost estimate does not reflect a LERRD value that exceeds the 35% non-Federal cost share. Table 6-9 outlines the project first costs of the recommended plan at the March 2016 price level. Table 6-10 displays the cost-share information for the recommended plan based on project first costs at the March 2016 price level.

Table 6-9. Estimated Costs of the Recommended Plan

Project Cost Component	Project First Cost (in $1,000, Mar 2016 price level)
Construction and Real Estate	
Construction Costs	$179,157
Real Estate Costs (including relocations)	$161,489
Planning, Engineering and Design (PED)	$74,559
Construction Management (CM)	$30,025
Monitoring	$1,090
Adaptive Management	$5,307
Total Estimated Cost	**$451,627**

Table 6-10. Cost-Share Estimate of the Recommended Plan

Ecosystem Restoration	Federal Cost ($1,000, Mar 2016 price level)	Non-Federal Cost ($1,000, Mar 2016 price level)	Total Cost ($1,000, Mar 2016 price level)
LERRD	$0	$158,069	$158,069
Excess LERRDs (100% non-Federal)	$0	$3,420	$3,420
Ecosystem Restoration (65% Federal/35% non-Federal)	$290,138	$0	$290,138
Cash Contribution/Reimbursement	**$3,420**	-$3,420	$0
Total Cost Share	**$293,558**	**$158,069**	**$451,627**
Overall Cost Share Percentage	65%	35%	100%

Table 6-11 provides an economic summary of the recommended plan. Interest during construction was computed using estimated project costs at the March 2016 price level, anticipated construction durations for each of the three sites (they range from two to six years each), and the current Federal discount rate (3.125% for fiscal year 2016), bringing total investment costs to $528,147,000. Operations and maintenance expenses have been estimated for the three sites and detailed OMRR&R manuals will be developed for each site during the PED phase. Annual costs were updated using the current cost estimate at the March 2016 price level. Total average annual cost is estimated at $21,880,000, with an average annual cost of $31,000 per AAHU. Table 6-12 summarizes site-specific costs and benefits. Note that total annual cost computed at the site-specific level is different from the annual cost of the recommended plan. This is based on the computation of interest during construction over the two to six year construction periods for each site versus 10-year overall construction of the recommended plan.

First costs for authorization purposes are estimated at $451,627,000 (March 2016 price level) and the fully funded cost estimate to the mid-point of construction is estimated at $539,839,000.

Table 6-11. Economic Summary of the Recommended Plan

	Cost and Benefit Summary of Recommended Plan (Oct 2015 price level)
Interest Rate (Fiscal Year 2016)	3.125%
Interest Rate, Monthly	0.26%
Construction Period, Months	120
Period of Analysis, Years	50
Estimated Cost	$451,627,000
Interest During Construction	$76,520,000
Investment Cost	$528,147,000
Average Annual Cost	
Amortized Cost	$21,017,000
Annualized OMRR&R	$863,000
Total Annual Cost	$21,880,000
Average Annual Benefits	
Average Annual Habitat Units (AAHUs)	716.5
Average Annual Cost/AAHU	$31,000

Note: OMRR&R costs have been estimated for the three sites in the recommended plan Detailed OMRR&R manuals will be developed for each site during the PED phase.

Table 6-12. Site-Specific Costs and Benefits of the Recommended Plan (Oct 2015 price level, 3.125% discount rate)

Site	Total Project Cost	Annual OMRR&R	Total Annual Cost	Acres Restored	AAHU
Duckabush	$90,523,000	$122,000	$3,711,000	38.1	12.3
North Fork Skagit River Delta	$99,299,000	$36,000	$4,070,000	256.1	53.7
Nooksack River Delta	$261,805,000	$705,000	$11,427,000	1807	650.5
Total	$452,286,000	$863,000	$19,208,000	2101.2	716.5

6.8 Implementation Requirements

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

6.8.1 Non-Federal Sponsor

The Washington Department of Fish and Wildlife (WDFW) is the non-Federal sponsor for the feasibility phase of the Nearshore Study. After project authorization, it is anticipated that the Corps will partner with WDFW to construct the three sites authorized in this study. Once a non-Federal partner is confirmed for construction, work-in-kind (WIK) credit provisions will be established and funding summaries will be developed for each year of design and construction.

6.8.2 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, confirmation that the non-Federal sponsor's cost share funding is available , and the budget constraints at the time of funding. Once Congress appropriates Federal construction funds, the Corps and the non-Federal partner(s) would enter into a Design Agreement (DA) and eventually a Project Partnership Agreement (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.

6.8.3 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Requirements

After completion of construction, the non-Federal sponsor(s) will assume operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) responsibility for the entire project footprint. OMRR&R costs have been estimated for the three sites included in the recommended plan; these estimates and a summary of OMRR&R activities for each site are included in Appendix B. The OMRR&R cost includes maintenance of all the infrastructure (levees, roads, bridges, etc.) that are included in the project. Although they are being modified,

many of these features are already being maintained currently by local entities. Detailed OMRR&R manuals will be developed for each site during the PED phase.

6.9 Tiered Implementation Master Plan: Sites for Additional Study

As described in section 4.3, a tiered implementation approach was developed for all 36 sites identified across Puget Sound deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and partners. The implementation master plan identifies various approaches for implementation of the 36 projects: GI projects to be recommended for construction (three sites), GI projects recommended for additional study (nine sites), projects to be completed under existing Corps construction authorities (CAP) or Puget Sound and Adjacent Waters Program (PSAW) (12 sites), and projects to be completed by others (12 sites).

The nine sites recommended for additional GI studies are the following:

- Big Beef Creek Estuary
- Big Quilcene River
- Chambers Bay
- Dugualla Bay
- Everett Marshland
- Lilliwaup River Estuary
- Tahuya River Estuary
- Snohomish River Estuary
- Telegraph Slough

More information about these nine sites is summarized in Appendix K. Table 6-13 also summarizes key details for the nine sites that require additional study under the General Investigations Program.

Table 6-13. Sites for Future General Investigation Study

Site Name	Sub-Basin	Strategy	Project Description	Acres Restored	Total Project Cost[1]
Dugualla Bay	Whidbey	Barrier Embayment	Restore tidal inundation to Dugualla Bay by removing levees, excavating tidal channels, and creating two small barrier beaches.	572	$88,355,000
Everett Marshland	Whidbey	River Delta	Restore floodplain habitat connectivity along the west bank of the Snohomish River by removing levees, excavating tidal channels, filling drainage ditches, and reconnecting streams to the tidal area.	829	$296,905,000
Telegraph Slough	San Juan	River Delta	Restore tidal inundation to Padilla Bay by removing levees and tide gates as well as excavating distributary channels to the Bay.	832	$256,124,000
Chambers Bay	South	Open Coastal Inlet	Restore tidal hydrology at the mouth of Chambers Bay by removing the Chambers Creek dam, removing armoring and fill, as well as daylighting and restoring creeks.	288	$298,002,000
Big Beef Creek Estuary	Hood Canal	Barrier Embayment	Restore historical spit and tidal inundation to Little Beef harbor by relocating the Seabeck Highway and excavating tidal channels in the estuary.	91	$37,376,000
Tahuya River Estuary	Hood Canal	Open Coastal Inlet	Restore tidal inundation to the Tahuya River estuary by replacing a roadway with a bridge and removing fill.	29	$30,305,000
Lilliwaup River Estuary	Hood Canal	Open Coastal Inlet	Restore tidal connectivity in the Lilliwaup River estuary by replacing the existing Highway 101 causeway with an elevated structure, removing accumulated sediment in the channel, and excavating tidal channels in the estuary.	19	$36,994,000
Big Quilcene River	Hood Canal	Open Coastal Inlet	Restore tidal hydrology at the mouth of the Big Quilcene River by removing dikes and fill, reconnecting distributary channels, and excavating pilot channels.	28	$37,600,000
Snohomish River Estuary	Whidbey	River Delta	Restore tidal hydrology in the Snohomish River estuary by removing levees, fill, and tide gates to reconnect the distributary channel to Union Slough (at the north end) and the Snohomish River (south end).	68	$126,593,000

[1]Estimated construction cost plus estimated $3 million feasibility study cost; prices presented in March 2016 dollars

The tiered implementation approach also identifies sites to be completed under the CAP or PSAW authority. Puget Sound and Adjacent Waters (Section 544, WRDA 2000) directs the Secretary to conduct studies and implement critical restoration projects in the area of Puget Sound, Washington and adjacent waters in consultation with the Secretary of Commerce, the Secretary of the Interior, the Governor of the State of Washington, tribal governments, and other stakeholders. According to the authority, selection of critical projects shall consider existing studies and plans.

The PSNERP study team, which included representatives from other federal and state agencies, Tribes, NGOs, academia, etc. went through a comprehensive process of identifying, screening, and selecting critical restoration projects within Puget Sound as detailed in Chapter 4. That process mirrors the directive included in the PSAW authority. Accordingly, the tiered implementation plan that resulted from the PSNERP study identifies the critical restoration projects in Puget Sound, and specifically identifies 4 of those projects for execution under the PSAW authority (Spencer Island, Quilceda Estuary Restoration, Twanoh State Park Beach Restoration and Twin Rivers). This PSNERP study also identifies the cost, acreage, and habitat units of these site-specific projects. Therefore, this study and the tiered implementation strategy meets the requirements identified by OMB (memo to ASA(CW) dated 15 June 2006).

The authorized appropriation for Section 544 is $40,000,000 with the Federal share of a single project limited to $5,000,000. Accordingly, the projects identified in the tiered implementation strategy will not exceed the remaining capacity under the PSAW authority.

Table 6-14 summarizes key details for the nine sites that require additional study under the General Investigations Program.

Table 6-14. Sites for PSAW or CAP Study

Site Name	Sub-Basin	Strategy	Project Description	Acres Restored[1]	Habitat Units[1]	Total Project Cost[1]
Chuckanut Estuary	San Juan	Open Coastal Inlet	Reconnect the Chuckanut Bay Estuary to Bellingham Bay by replacing an existing railway berm with a bridge.	88	5	$16,300,000
Deepwater Slough	Whidbey	River Delta	Restore tidal wetlands by lowering and breaching dikes, planting native vegetation and reconnecting tidal and distributary channels to Freshwater, Deepwater, and Steamboat Sloughs.	270	90	$9,900,000
Everett Riverfront Wetland	Whidbey	River Delta	Improve connectivity between the mainstem Snohomish River and large freshwater wetland complexes by excavating distributary channels, removing bulkheads, and planting native vegetation.	55.5	30	19,500,000
Harper Estuary	Hood Canal	Open Coastal Inlet	Restore unrestricted tidal exchange in Harper Estuary by removing bulkheads and hardened debris as well as restoring tidal channels in the estuary.	6.2	2	$12,200,000
Livingston Bay	Whidbey	Barrier Embayment	Restore large area of salt marsh and mudflats by excavating starter channels to initiate tidal marsh development, filling internal drainage ditches, lowering internal dikes, and planting native vegetation.	239	40	$13,100,000
McGlinn Island	Whidbey	River Delta	Improve the hydraulic connection between the North Fork Skagit River and the Swinomish Channel by creating a new distributary channel from Dunlap Bay to the Swinomish Channel.	940	0.2	$10,000,000
Quilceda Estuary	Whidbey	River Delta	Restore historic marsh by removing berms along Quilceda Creek, excavating fill material, eliminating old agricultural ditches, creating new tidal channels, and planting native vegetation.	9	3	$2,600,000
Sequalitchew Creek	South	Open Coastal Inlet	Restore the stream mouth and open coastal inlet morphology by removing armor and nearshore fill around the mouth of the Sequalitchew Creek ravine.	3.5	0.5	$14,000,000
Spencer Island	Whidbey	River Delta	Restore tidal exchange to Spencer Island by breaching an existing dike and creating a tidal channel network in the interior of the island	313	136	$3,700,000

Site Name	Sub-Basin	Strategy	Project Description	Acres Restored[1]	Habitat Units[1]	Total Project Cost[1]
Twanoh Beach	Hood Canal	Barrier Embayment	Restore valuable coastal embayment by removing shoreline armoring, allowing sand and gravel beach restoration to support spawning grounds for forage fish.	4	2	$2,600,000
Twin Rivers	Strait	Beach	Remove rock armoring and sheet pile walls, and fill to restore sand and gravel beaches that serve as spawning grounds for forage fish.	4	0.15	$3,600,000
WDNR Budd Inlet Beach	South	Beach	Restore sediment supply and transport by removing armor and debris, placing large woody debris, channel rehabilitation, and beach nourishment.	2	1	$10,400,000

[1]Estimates for acres restored, habitat units, and total project costs are conceptual estimates only. Costs, benefits, and acres restored will be refined when additional studies are completed for each site.

7 ENVIRONMENTAL COMPLIANCE OF THE RECOMMENDED PLAN*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

7.1 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

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-required documents must provide detailed information on the proposed action and alternatives, environmental effects of the alternatives, mitigation measures, and any adverse environmental effects that cannot be avoided if the proposal is implemented. Agencies must demonstrate that decision makers have considered these factors prior to undertaking actions.

The Corps published a Notice of Intent to prepare an EIS in the Federal Register on October 2, 2009, and held four scoping meetings around the Puget Sound area. All comments received during scoping phase were considered in determining whether it will be in the public interest to proceed with the proposed project. The Draft FR/EIS was published for a public comment period initially from October 10, 2014 through November 24, 2014. Responding to public request, the comment period was extended through January 8, 2015. Public comments and agency responses appear in Appendix H. The Final FR/EIS will be published for a 30-day period, followed by a Record of Decision. This is intended to achieve NEPA compliance for the proposed project.

7.2 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 to ensure that proposed actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats.

ESA consultation was conducted via the Fish Passage and Restoration Projects Biological Opinion issued to the Corps' Seattle District in 2008, and coverage of species under USFWS under this Biological Opinion has been extended through 2018. The Corps received letters from NMFS and USFWS indicating their support for using this process for ESA consultation in 2012. The USFWS provided an approval letter for the Recommended Plan on February 4, 2016. NMFS provided a Biological Opinion to specifically cover the actions proposed by the Nearshore Study. The issuance of this consultation with explicit inclusion of all Nearshore Study sites and features was provided to the Corps on February 11, 2016.

7.3 FEDERAL WATER POLLUTION CONTROL ACT OF 1972 (CLEAN WATER ACT)

The Clean Water Act (33 U.S.C. §1251 et seq.) requires Federal agencies to protect waters of the United States. The regulation implementing the Act disallows the placement of dredged or fill

material into water unless it can be demonstrated there are no practical alternatives that are less environmentally damaging. The sections of the CWA that apply to the Nearshore Study proposal are 401 regarding discharges to waterways, 402 regarding discharges of storm water, and 404 regarding fill material in waters and wetlands.

The assumptions for water quality and CWA compliance were that all data shown on WDOE's website are the best available information, none of the water quality conditions at any site would prevent a feasible restoration action, standard BMPs employed during construction would be sufficient to avoid significant impacts, and that WDOE would be able to issue 401 certification upon receiving the required level of detail in site designs. The vast acreages of wetland restoration are assumed to have only temporary, minor negative effects on water quality and will improve water quality conditions in the long term, especially in cases where buffers between a waterbody and agricultural land are established or increased.

Section 401

Any project that involves placing dredged or fill material in waters of the United States or wetlands, or mechanized clearing of wetlands requires a water quality certification from the state or tribal agency as delegated by EPA. For most sites of the Nearshore Study, the delegated authority is WDOE. For the Nooksack site, the EPA has delegated authority to the Lummi Nation for their lands while Ecology maintains jurisdiction over state and private lands. The Corps initiated coordination with WDOE and the Lummi Nation in 2014 for their certification that the proposed Federal action will not violate established water quality standards. The Corps received a letter from WDOE on January 8, 2016 stating their support for the Corps to continue pursuing these projects and continued coordination in formal permit phase (see Appendix J). The Lummi Nation referenced their letter in support of the project, which they provided on November 25, 2014, and requested that the Corps reinitiate coordination for 401 certification when more detailed designs are available prior to construction. The Corps will submit the 401 water quality certification request at the 65% design phase and will receive the certification before completion of the 95% design package. Based on Seattle District experience, WDOE typically issues a 401 certification within a 6-9 month period. The Corps has anticipated standard best management practices that are typically required by WDOE for similar ecosystem restoration projects and have accounted for those in the design and associated cost estimate.

Section 402

The National Pollutant Discharge Elimination System (NPDES), controls discharges into waters of the United States. In 1987, the Clean Water Act was amended to require the EPA to establish a program to address storm water discharges. In response, the EPA promulgated the NPDES storm water permit application regulations. The Corps will ensure that each restoration site is covered by a Section 402 Construction Storm water General Permit. Best management practices for erosion and sedimentation control will be included in the design for each restoration site.

Section 404

In 1972, Section 404 established a program to regulate the discharge of dredged or fill material into the navigable waters of the United States. Much earlier, the Rivers and Harbors Act of 1899 (33 U.S.C. §403) defined navigable waters of the United States as "those waters that are subject to the ebb and flow of the tides and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce." The Clean Water Act built on this and defined waters of the United States to include tributaries to navigable waters, interstate wetlands, wetlands that could affect interstate or foreign commerce, and wetlands adjacent to other waters of the United States. To comply with Section 404, it is necessary to avoid negative effects to wetlands wherever practicable, minimize effects where they are unavoidable, and compensate for effects in some cases. The Nearshore Study's Recommended Plan has undergone a Section 404(b)(1) evaluation. See Appendix J.

7.4 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. §470), as amended through 1992 (Public Law 102-575), establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring, and maintaining the nation's historic and cultural environment. Section 106 of NHPA requires Federal agencies to account for the indirect, direct, and cumulative effects of their undertakings on historic properties (i.e., archaeological sites, Traditional Cultural Properties, buildings, structures, objects, districts, and landscapes listed in or eligible for listing in the National Register). Section 106 and its implementing regulations at 36 CFR 800 establish procedures for Federal agencies to follow in identifying historic properties and assessing and resolving effects of their undertaking on them, in consultation with State Historic Preservation Officers (SHPO), Indian tribes, Native Hawaiians, and the Advisory Council for Historic Preservation (ACHP), as appropriate. Other parties may participate in the Section 106 consultation process, including but not limited to applicants for Federal assistance, permit and license applicants, certified local governments, and other groups or individuals with an economic, social, or cultural interest in the project. Maximum public involvement in the process is encouraged.

The Corps consulted with the SHPO, ACHP, interested Tribes, and the public on a Programmatic Agreement (PA; see Appendix D) regarding the three sites of the recommended plan (Nooksack River Delta, North Fork Skagit River Delta, and Duckabush Estuary). The PA was fully executed in June 2016. The PA provides for deferred identification and evaluation for Section 106 under 36 CFR § 800.4 (b) (2) and 36 CFR § 800.14 (b) and provides a framework under which the Corps will comply with Section 106 once Congressional approval and authorization is granted. Letters were sent on March 5, 2013 to the SHPO and ACHP detailing the project. The letter stated that the Corps was exploring the possibility of developing a PA or MOA to defer identification and evaluation until specific aspects or location of alternatives were more fully defined, but also requested advice and guidance on the appropriate mechanism to fulfill the agency's Section 106 responsibilities. The SHPO responded April 3, 2013 stating that they

looked forward to consulting with Corps. The ACHP responded March 22, 2013 stating that they would participate in consultation. Follow-up letters were sent on September 30, 2015 to the ACHP, SHPO and interested Tribes providing a project update and stating that the Corps elected to defer identification and evaluation under Section 106 of the NHPA. Emails were sent to interested members of the public that may have an interest in the restoration sites in the recommended plan. The ACHP reiterated their interest in participating in the development of a PA by email on October 30, 2015. The PA was completed in 2016 to include the three sites of the Recommended Plan. The PA outlines the Section 106 procedures that will be undertaken once Congressional approval and authorization is granted. Procedures include which Section 106 tasks need to occur prior to construction (e.g. fieldwork), how Section 106 consultation will occur, how determinations of eligibility will be made, how findings of no adverse effect will be determined, how findings of adverse effects will be made, and how the PA will be implemented and dispute resolution procedure. In addition, the PA provides for a variety of treatment measures that can be used for mitigation of an adverse effect (See Appendix E of the PA). The treatment measures are standard types of mitigation actions used for adverse effects and the costs of these treatment measures have been taken into account during cost estimation for this project. Signatories to the PA include the Corps, the Washington SHPO, the ACHP, WDFW, and the Lummi Nation. The Lummi Nation is a signatory due to the Nooksack restoration project extending onto the reservation and because the Lummi Nation has a recognized Tribal Historic Preservation Officer (THPO) who has assumed the responsibilities of the State Historic Preservation Officer (SHPO) on tribal lands. The Washington Department of Transportation (WSDOT) is an invited signatory due to their interest in the Duckabush Bridge located in the Duckabush restoration site. For any other sites that receive authorization and funding, these will undergo a separate consultation process for compliance with NHPA.

7.5 FEDERAL TREATY OBLIGATIONS

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 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 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.

Tribes have had representation in the Nearshore Study planning phase through the Northwest Indian Fisheries Commission, as well as the Lummi Nation's participation on the Steering Committee. The Nearshore Study team anticipates that the proposed ecosystem restoration would have significant benefits to salmonid and shellfish resources, which are of economic and cultural

value to the tribes within the project area. Implementation of the recommended plan would improve the affected nearshore areas, ultimately benefiting Puget Sound tribes and consistent with the Federal government's trust responsibility to them.

7.6 EXECUTIVE ORDER 13175, CONSULTATION AND COORDINATION WITH INDIAN TRIBAL GOVERNMENTS

Executive Order 13175 (6 November 2000) 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 Puget Sound's federally recognized tribes throughout the course of the study.

7.7 BALD AND GOLDEN EAGLE PROTECTION ACT

The Bald and Golden Eagle Protection Act (16 U.S.C. §668-668c), enacted in 1940 and amended several times since then, prohibits anyone without a permit issued by the Secretary of the Interior from "taking" eagles including their parts, nests, or eggs and applies criminal penalties to persons. The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Construction activities associated with the proposed actions may disturb bald and golden eagles due to elevated noise levels and presence of heavy machinery. The Corps would avoid and minimize impacts through construction timing windows for each site identified containing or in close proximity to a breeding area, and, if nests and/or roosts are nearby, monitor and coordinate with USFWS.

7.8 CLEAN AIR ACT

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 Puget Sound 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. In accordance with the CAA and its amendments, National Ambient Air Quality Standards (NAAQS) have been established by EPA for several criteria pollutants including lead (Pb), ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and particulates with aerodynamic diameters of less than 10 and less than 2.5 microns (PM_{10} and $PM_{2.5}$). Construction activities associated with the proposal will create air emissions, but these are not expected to affect implementation of Washington's CAA implementation plan.

Washington uses air-monitoring data to determine whether air quality in the State meets the national standards. Areas where the standards are met are designated as attainment areas, and areas where the standards are exceeded are designated as nonattainment areas (NAA). This will not be a concern on this project, as none of the proposed actions would occur in Washington's single nonattainment area. Construction sites of the magnitude included in the Recommended Plan are not typically a concern in attainment areas. The estimated emissions for the sites included in the proposed project are expected to meet the standards set forth by the EPA and implemented by Washington State.

7.9 COASTAL ZONE MANAGEMENT ACT

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. 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." The delegated authority for review of consistency with the law is WDOE. In compliance with State law, each of the 15 coastal counties in Washington has developed its own Shoreline Master Program in compliance with the State Shoreline Management Act. The Corps has prepared a CZMA Consistency Determination for each site according to the relevant county or local code and has determined that the Recommended Plan is substantively consistent with the enforceable polices of the State Coastal Zone Management Program. Those enforceable policies include compliance with the Clean Water Act. Therefore, the Corps will submit the CZMA Consistency Determination along with the 401 Water Quality Certification Request to WDOE at the 65% design phase and will receive the CZMA consistency concurrence before completion of the 95% design package. In Seattle District's experience, CZMA consistency concurrence does not include any conditions on the proposed work.

7.10 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act of 1934 as amended (16 U.S.C. §661-667e) ensures that fish and wildlife conservation is given equal consideration as is given to other features of water-resource development programs through planning, development, maintenance, and coordination of wildlife conservation and rehabilitation. Whenever the waters of any stream or other body of water are proposed to be impounded, diverted, deepened or otherwise controlled or modified, the Corps shall consult with the USFWS and NMFS as appropriate, and the agency administering the wildlife resources of the state. Any reports and recommendations of the wildlife agencies shall be included in authorization documents for construction or modification of projects. The Corps shall consider the reports and recommendations of the wildlife agencies and include such justifiable means and measures for wildlife mitigation or enhancement as the Corps finds should be adopted to obtain maximum overall project benefits. Recommendations provided by the USFWS in Coordination Act Reports must be specifically addressed in Corps feasibility reports.

The Corps initiated consultation with USFWS in 2002 shortly after the start of the Nearshore Study's Feasibility Phase. USFWS has provided three Planning Aid Letters in 2005, 2007, and 2011, and has provided a USFWS biologist to be a member of the Nearshore Science Team and the Nearshore Steering Committee. USFWS has been supportive of Nearshore Study efforts and the Corps has been incorporating USFWS technical advice into project planning, strategies, objectives, site screening, and conceptual designs. NMFS has been equally supportive of the Nearshore Study and has had representation on the Nearshore Study's Steering Committee and has been a participating organization since early in the Feasibility Phase. In addition, NMFS contributed to an analysis of affected threatened and endangered species and provided conservation measures to implement during restoration work. The Corps received a Draft Coordination Act Report (CAR) from USFWS on January 21, 2016. USFWS and NMFS submitted a joint Final CAR and provided this to the Corps on March 4, 2016 (see Appendix J).

The complete list of recommendations appears in the Draft and Final CARs in Appendix J. Several key recommendations are summarized below. Through coordination prior to receiving the Draft CAR, the Corps was aware of these recommendations and incorporated them into project design development. The Corps' response follows each USFWS recommendation:

- Use best management practices (BMPs) and conservation measures to minimize short-term construction impacts
  - The Corps will apply standard BMPs for minimizing environmental impacts during construction. BMPs and conditions received in the Clean Water Act 401 certification and ESA consultation documents will be incorporated into site designs during PED.
- Avoid pile driving for bridge replacement features
  - The current level of design includes only cast-in-place piers for bridge replacement and no pile driving. Some vibratory pile removal may be necessary, but this will be held to the minimum noise impacts possible.
- Follow NMFS guidelines for riparian buffers
  - Wherever possible, the maximum available width of riparian buffer has been designed into the site-specific plans.
- Apply creativity and flexibility in working with landowners to maximize ecosystem benefits
  - Lands, easements, and rights-of-way are the responsibility of the non-Federal sponsor, who will conduct landowner outreach regarding the project. The Corps will assist with this effort wherever appropriate.
- Continue coordinating with tribal governments and representatives
  - The Corps solicited input throughout the NEPA process from all stakeholders, which included directly contacting Puget Sound tribes multiple times. The Corps will continue tribal coordination throughout PED and looks forward to having tribal input.
- Continue coordinating with USFWS through the next design phase
  - The Corps will continue coordinating with all relevant natural resource agencies including but not limited to USFWS, NMFS, and WDFW throughout PED.

7.11 MAGNUSON-STEVENS SUSTAINABLE FISHERIES AND CONSERVATION ACT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), (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. The assessment also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

EFH consultation has been completed via the Biological Opinion provided by NMFS on February 11, 2016, included in Appendix J. This Biological Opinion states that the temporary and spatially constrained increases in turbid water during construction will adversely affect EFH for Pacific Coast salmon. The measures required in the ESA consultation to minimize the effects of construction on water quality would have a similarly conservative effect on EFH. Therefore, NMFS recommends implementing Term and Condition 1(a)(1) as described in the Biological Opinion found in Appendix J. NMFS stated that implementing the minimizations measures as described in ESA consultation for restoration actions in Washington State (NWS-2008-3598),including the use of isolation devices, avoiding the need for pile driving, monitoring of water quality, and providing NMFS with additional information on design and construction as the project proceeds, would protect by avoiding or minimizing the adverse effects to approximately 20 acres of EFH for Pacific Coast salmon.

7.12 MARINE MAMMAL PROTECTION ACT

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. All marine mammals are protected under the MMPA regardless of whether they are endangered, threatened, or depleted. Marine mammal species that are observed in Puget Sound include harbor seal (*Phoca vitulina*), killer whale (*Orcinus orca*), Steller sea lion (*Eumetopias jubatus*), Northern elephant seal (*Mirounga angustirostris*), California sea lion (*Zalophus californianus*), harbor porpoise (*Phocoena phocoena*), Dall's porpoise (*Phocoenoides dalli*), Minke whale (*Balaenoptera acutorostrata*), and gray whale (*Eschrichtius robustus*) (Orca Network 2011). The primary concern for protection of marine mammals will be underwater noise from construction sites, which is described in detail in section 5.1.8. The Corps consulted with NMFS on effects to marine mammals in conjunction with the ESA Section 7 consultation. The Corps anticipates implementing all practicable conservation measures. For all restoration sites in which the sound levels are predicted to be louder than the acoustic thresholds for harassment of marine mammals, the Corps will use BMPs as described in section 5.7.4. as appropriate for each site and will coordinate with NMFS to determine whether a Marine Mammal Monitoring Plan is needed.

7.13 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act of 1918 (16 U.S.C. §703-712), as amended in 1989, implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, it is unlawful to hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not. The proposed work will not result in the hunt, take, capture, or killing of migratory birds. Construction activities may disturb migratory birds due to noise and presence of large machinery. These effects will be minimized by avoiding disruptive work during the typical nesting season, and surveying the sites for nests.

7.14 HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE LAWS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) is designed to clean up sites contaminated with hazardous substances; remediating abandoned hazardous waste sites, by establishing legal liability, as well as a trust fund for cleanup activities, called "Superfund". The Resource Conservation and Recovery Act (RCRA) gives the EPA the authority to control hazardous waste from "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. The Toxic Substances Control Act (TSCA) of 1976 provides EPA with authority to require reporting, record-keeping, and testing requirements, and restrictions relating to chemical substances and/or mixtures. TSCA addresses the production, importation, use, and disposal of specific chemicals including polychlorinated biphenyls (PCBs), asbestos, radon, and lead-based paint. None of the proposed restoration sites are on the EPA National Priorities List, and there are no known HTRW sites identified within the project footprints. If chemical contaminants or regulated substances are found on a particular site proposed for restoration, the Corps will comply with current policies and coordinate with the local sponsor to ensure that remediation actions are taken as necessary prior to project implementation.

7.15 THE GENERAL BRIDGE ACT

The General Bridge Act of 1946 (33 U.S.C. §525-533) prohibits the construction of any bridge across navigable waters of the United States unless first authorized by the Coast Guard. The Coast Guard approves the location and clearances of bridges through the issuance of bridge permits or permit amendments, under the authority of the General Bridge Act of 1946, Section 9 of the Rivers and Harbors Act of 1899, and other statutes. New construction, reconstruction, or modification of a bridge or causeway over navigable waters of the United States requires permit issuance from the Coast Guard. A bridge permit is the written approval of the location and plans of the bridge or causeway to be constructed or modified. One of the sites in the Recommended Plan will involve replacement of a bridge, which will require a permit from the Coast Guard. The Corps will design and build the bridge according to Coast Guard regulations, and the permit will be obtained when the final design is available.

7.16 FARMLAND PROTECTION POLICY ACT

The FPPA is intended to minimize the impact Federal programs and actions have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that to the extent possible Federal programs and actions are administered to be compatible with state, local units of government, and private programs and policies to protect farmland. The FPPA does not authorize the Federal Government to regulate the use of private or non-Federal land or, in any way, affect the property rights of owners. For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be in use as cropland. It can be forestland, pastureland, cropland, or other land, but not water or urban built-up land.

The Corps initiated the process for compliance by providing the Farmland Conversion Impact Rating Forms to the Natural Resources Conservation Service (NRCS) for their review and input in October 2015. NRCS responded with their evaluation in October 2015. The rating forms were finalized in July 2016 and provided to the NRCS to complete the compliance process.

Although there will be conversion of farmland to tidal wetland, it is necessary to restore ecosystem processes at the project sites. Historic conversion of wetlands to farmland was commonplace along Puget Sound rivers due to fertile soil and flat topography. Impacts to farmland at a regional scale are minimal, as the total acreages are a small fraction of the total acreage in the counties where the projects are located.

7.17 EXECUTIVE ORDER 12898 ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" provides that each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Environmental justice concerns may arise from impacts on the natural and physical environment, such as human health or ecological impacts on minority populations, low-income populations, and Indian tribes or from related social or economic impacts.

The Corps evaluated the location and design of each restoration site to determine whether they would affect minority populations, low-income populations, and Indian tribes. The EPA Environmental Justice Viewer was used to determine whether protected groups are present in the proposed restoration areas. This evaluation found that the sites are either within park limits with no residents nearby or the demographics of the nearby populations were mostly non-minority and above poverty levels, with one exception. One site is located within Lummi Nation lands. Coordination of the proposed site with key stakeholders including the Lummi Nation has occurred throughout the planning process. In the case of the Indian tribal land, the proposed restoration would improve the affected nearshore area to the benefit of the tribe and would be

designed to avoid negative effects to tribal resources. Therefore, in accordance with Title III of the Civil Rights Act of 1964 and Executive Order 12898, it has been determined that the project would not directly or through contractual or other arrangements, use criteria, methods, or practices that discriminate on the basis of race, color, or national origin, nor would it have a disproportionate effect on minority or low-income communities.

7.18 EXECUTIVE ORDER 11988 FLOODPLAIN MANAGEMENT

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.

There are eight steps reflecting the decision making process required in this Executive Order. The eight steps and responses to them are summarized below.

1. **Determine if the proposed action is in the base floodplain.**
   The proposed actions are located within the base floodplain for the Duckabush River, Nooksack River, and North Fork Skagit River.

2. **If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain.**
   As the primary objective of the project is aquatic ecosystem restoration, there are no practicable alternatives completely outside of the base floodplain for the three sites that would achieve this objective.

   As described in section 6.1.3.7 and section 6.1.2.8, the study team completed an induced flooding analysis to determine whether mitigation for induced flooding (e.g., inclusion of setback levees) is justified as part of this ecosystem restoration project. Compared to acquisition of property, flowage easements, or other non-structural measures, the analysis indicates that setback levees are the preferred method to achieve the ecosystem restoration benefits at the Nooksack River Delta and North Fork Skagit River Delta. The study team also completed a qualitative evaluation of different levels of flood risk management for the setback levees. The team evaluated setback levees that provide a higher level of flood risk management than the existing levees, setback levees that provide an equivalent level of flood risk management as the existing levees, and setback levees that provide a lower level of flood risk management compared to the existing levees. Setback levees that provide equivalent

levels of flood risk management to the existing levees are the minimum cost effective structure necessary to realize ecosystem restoration outputs at the site.

3. **Provide public review.**
   The proposed project has been coordinated with the public, government agencies, and interested stakeholders. The Draft FR/EIS was released in October 2014 and a public meeting was held in November 2014. Numerous comments were received on the Draft FR/EIS, which have been included and responded to in this Final FR/EIS (Appendix H).

4. **Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values.**
   Chapter 4 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated and potential impacts and benefits were evaluated. The anticipated impacts associated with the recommended plan are summarized in Chapters 4, 5, and 6 of this report. While construction of project features would result in mostly minor and temporary adverse impacts to the natural environment, the proposed restoration would result in a substantial and long-term increase in habitat values including an increase in the quantity and quality of riparian and aquatic habitat. For each resource analyzed in Chapter 5, wherever there is a potential for adverse impacts, appropriate best management practices or other environmental considerations were identified. As there is a net benefit to biological resources, no biological mitigation is required for the recommended plan.

5. **Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.**
   Implementing the recommended plan would have no significant flooding impacts on human health, safety, and welfare.

6. **Reevaluate alternatives.**
   Chapter 4 of this document presents an analysis of alternatives. There are no practicable alternatives completely outside of the base floodplain for the three sites that would achieve study objectives.

7. **Issue findings and a public explanation.**
   The public will be advised that no practicable alternative to locating the proposed action in the floodplain exists, as indicated in Item 3 above.

8. **Implement the action.**
   The proposed project does not contribute to increased development in the floodplain and does not increase flood risk, but rather it restores "natural and beneficial values." The recommended plan is consistent with the requirements of this Executive Order.

7.19 EXECUTIVE ORDER 11990 PROTECTION OF WETLANDS

Executive Order 11990 entitled Protection of Wetlands, dated May 24, 1977, requires Federal agencies to avoid adversely affecting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order. One of the primary goals of this project is to restore wetlands along the Puget Sound shoreline that have been lost due to dikes, fill, and armoring. The proposed actions would be largely beneficial to wetlands. The exception is potential change to freshwater wetlands that have established due to interrupted tidal flow. Once stressors such as dikes and berms are removed, salt water will inundate these freshwater wetlands and they would slowly transition to emergent brackish marsh. This transition would likely cause a functional increase in habitat and water quality. Any action potentially causing a conversion of wetland type will be evaluated by the Corps and coordinated with WDOE.

7.20 EXECUTIVE ORDER 13045 PROTECTION OF CHILDREN FROM ENVIRONMENTAL HEALTH RISKS AND SAFETY RISKS

Executive Order 13045, requires each Federal agency to "identify and assess environmental risks and safety risks [that] may disproportionately affect children" and ensure that its "policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks." The Corps has analyzed the project footprint and surrounding area for the project's potential to cause health and safety risks to children. The project sites where construction activity will occur are more than one mile away from any schools, parks, libraries, and grocery stores. Infants and children are not expected to be exposed to any health or safety risks because of these actions; therefore, this project has no environmental or safety risks that may disproportionately affect children. The plan is in compliance.

8 PUBLIC INVOLVEMENT & PEER REVIEW

Stakeholder involvement and agency coordination have been vital components of the Nearshore Study since its start in 2001. The relationships among the Study team and the many member organizations are an important facet of a collaborative planning approach to stakeholder involvement. Stakeholders are integral in helping provide input for defining restoration opportunities, objectives, and constraints, and for developing restoration strategies, which ultimately support development of the range of alternatives to be analyzed for feasibility and environmental compliance. Federal and state agencies have also participated in the NEPA process, including a process to integrate State Environmental Policy Act (SEPA) requirements with the NEPA process. In accordance with Engineering Circular 1105-2-409 (Planning in a Collaborative Environment; USACE 2005), representatives of Federal and state agencies have been invited to be members of the Project Delivery Team and the other Nearshore Study teams.

8.1 PROJECT DELIVERY TEAM

The Project Delivery Team (PDT) is a multi-disciplinary, multi-agency team responsible for the successful development and execution of all aspects of the study. The PDT comprises six standing teams, with agency, non-governmental organization and other representatives serving on the Executive Committee (EC), Steering Committee (StC), Project Management Team (PMT), Nearshore Science Team (NST), Implementation Team (IT), and Stakeholder Involvement Team (SIT). The PDT facilitates the interagency collaboration and coordination necessary for study execution and successful delivery of a quality product. In addition to formal review requirements prescribed in Corps policy, NEPA-required coordination with Federal and State agencies and tribes is facilitated through the PDT. The PDT can expand and contract as necessary to include all necessary expertise, ad hoc teams, and work groups for study execution.

8.1.1 Executive Committee

The role of the Executive Committee is to oversee implementation of the project; to receive progress reports from the Steering Committee; and to serve as an advocate for the Nearshore Study in international, Federal, State, tribal, and local government forums. The Executive Committee provides broad policy oversight and interagency/governmental coordination at executive levels of leadership.

8.1.2 Steering Committee

The role of the Steering Committee is to guide implementation of the project management plan, to develop any proposed changes to the project management plan, to advise and recommend actions to the project managers related to the implementation of the project management plan, to maintain a set of policies and procedures, and to report to the Executive Committee. The Steering Committee works to provide operational support and guidance to the PMT in

completing the Nearshore Study, as well as insuring effective integration of products and results into activities outside of the Nearshore Study.

8.1.3 Nearshore Science Team

The NST is an interdisciplinary team comprised of senior scientists representing various fields. The NST works to ensure that the Nearshore Study is informed by best available science. They have also helped ensure that peer-review is effectively implemented for rigorous evaluation of study technical products and the program's use of internally and externally developed scientific information.

8.1.4 Implementation Team

The role of the Implementation Team (IT) is to develop an approach to the identification, evaluation, and assessment of potential restoration and protection projects and actions, and to identify opportunities at specific geographic locations to apply and test Nearshore Study products, guidance, and principles. The IT works to transfer scientific and technical products to the implementation of the Nearshore Study, including selection and evaluation of potential sites, and to restoration and protection work external to the Nearshore Study.

8.1.5 Project Management Team

The Project Management Team (PMT) comprises leads from the Implementation Team, Nearshore Science Team, and the Federal and local project managers. This group works to ensure coordination of activities across the program and make collective decisions on allocation of program resources toward critical path tasks.

8.1.6 Stakeholder Involvement Team

The role of the Stakeholder Involvement Team is to implement the Stakeholder Involvement Plan, which has four objectives: 1) fostering broad program understanding and support, 2) developing and reviewing restoration and protection goals and objectives, 3) involving stakeholders in the NEPA process, and 4) developing and advancing a Puget Sound Nearshore Study project site list.

8.2 AGENCY COORDINATION

Preparation of this report was coordinated with appropriate congressional, Federal, State, and local interests as well as environmental groups and other interested parties. Since the original cost-sharing agreement was signed in September 2001, many Federal, local, and State agencies, as well as non-governmental organizations beyond the Corps and WDFW have joined the Nearshore Study team as shown in section 8.1. Their participation has broadened the base of Federal and local support, and expanded the technical and financial resources being applied to the general investigation and the broader activities of the Nearshore Study.

8.2.1 Federal Cooperating Agencies

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. While many Federal agencies have extensively participated in early Nearshore Study activities, there is no formal cooperating agency for this study. The EPA declined to be a cooperating agency upon formal invitation from the Corps.

8.2.2 Tribal Coordination

The Corps has engaged in formal and informal coordination with the federally recognized tribes of the Puget Sound throughout the feasibility phase. Coordination with tribes is ongoing and the Corps will continue to offer opportunities to meet informally or through government-to-government meetings. Appendix J shows which tribes and what dates the Corps met with and copies of letters that the Corps sent and received from the tribes. Tribal coordination will continue throughout the feasibility phase, PED, and construction in accordance with Executive Order 13175 Consultation and Coordination with Indian Tribal Governments.

8.2.3 Agency Views

Many Nearshore Study partners, the Washington State Governor, and five Congress members have provided letters that express their perspectives on the study, including the following in order of receipt:

- U.S. Environmental Protection Agency (EPA)
- Washington State Department of Ecology (WDOE)
- Skagit County (Skagit)
- U.S. Fish and Wildlife Service (USFWS)
- Washington Department of Fish and Wildlife (WDFW)
- People For Puget Sound (PFPS)
- Northwest Straits Commission (NWSC)
- The Nature Conservancy (TNC)
- Washington State Department of Natural Resources (DNR)
- University of Washington (UW)
- King County (King)
- Puget Sound Salmon Recovery Lead Entities (LE)
- U.S. Geological Survey (USGS)
- Puget Sound Partnership (PSP)
- Washington State Recreation and Conservation Office (RCO)
- Governor Christine Gregoire, State of Washington
- Representatives Inslee, Dicks, Reichert, McDermott, and Smith

8.3 PUBLIC INVOLVEMENT ACTIVITIES

8.3.1 Study Website

The Nearshore Study maintains a website (*www.pugetsoundnearshore.org*), which serves as the primary resource for information including study background, events, technical reports, program documents, and progress of the study. The site is updated as new products and reports are released. The site underwent a major update in June 2012 to make it more interesting and more usable by the public. The Nearshore Data Site (*www.psnerp.ekosystem.us/*) is a complementary website that includes a geospatial mapping feature to view proposed activities and relevant data layers derived from Nearshore Study technical products.

8.3.2 Stakeholder Involvement and Site Visits

The success of Corps planning efforts depends to a great extent on establishing partnerships with project proponents and other key stakeholders. Since the inception of the Nearshore Study, team members have met and developed relationships with public officials, congressional members and staff, members of non-governmental organizations, Federal partners, tribal government representatives, and local and State agencies. During the site selection process, the Nearshore Study team conducted site conversations with proponent(s) to ground-truth and fact-check project details. Prior to development of the conceptual designs for 36 sites, Nearshore Study team members as well as design consultants and project proponents met onsite to view and tour accessible lands to gain an understanding of on-the-ground conditions and constraints.

Project proponents were included in review of the draft conceptual design reports and their comments were incorporated into the final product. In early June 2012, project proponents and associated salmon recovery lead entity coordinators were notified via U.S. mail of their project's status with regard to the TSP for the Draft FR/EIS. Project proponents were offered an opportunity to meet with Nearshore Study team to better understand what it means for their project site to be part of the TSP. Next steps include a more comprehensive landowner and public outreach plan tailored to each of the TSP sites. This outreach work will use input from each project proponent and advocates and will follow the Nearshore Study's Stakeholder Outreach and Involvement Plan for Potential Restoration Projects (ESA 2011a).

8.3.3 Media Coverage

The Nearshore Study and its partner agencies have received positive media coverage since project inception. Coverage includes feature articles from the *Associated Press, Seattle Times, Seattle PI, Daily Olympian,* and *Daily Journal of Commerce*. In 2003, the Study team organized a project-specific media event, which highlighted new technology being used to obtain bathymetric data to improve nearshore zone mapping in Puget Sound. Since the establishment of the Puget Sound Partnership (PSP) in 2007, the Study team has coordinated media contact and

other broad stakeholder engagement with PSP staff to ensure consistency of messaging, aligning the concerted work to support broader Puget Sound recovery actions.

8.3.4 Conferences/Workshops

Nearshore Study team members and associates have represented the Nearshore Study at numerous national and local conferences, ensuring that the Nearshore Study remains relevant and current in ecosystem-based restoration. This participation has brought positive recognition for the science-base and technical rigor of the Nearshore Study. Conference participation includes the Restore America's Estuaries Conference, the Salish Sea Ecosystem Conference (formerly the Puget Sound - Georgia Basin Conference), the International Conference on Ecology and Transportation, the Corps' and TNC's National Partnership Conference, the National Conference for Ecosystem Restoration, Coastal Habitats in Puget Sound (U.S. Geological Survey sponsored workshops), Salmon Recovery Conference (WA Recreation and Conservation Office sponsored), and the Coastal Zone Conference. Additionally, Nearshore Study team members have given informational presentations to the Mason County Shoreline Technical Advisory Group and the Pacific Coast Joint Venture Steering Committee.

8.3.5 Nearshore Study Sponsored Workshops

The Nearshore Study has held several meetings and workshops, including a Science Symposium, three Strategic Science Peer Review Panels, Valued Ecosystem Component Workshops, Shoreline Armoring Work Group, Navigating the Nearshore Workshop, Problems and Opportunities, Existing and Future Conditions Workshop, Informational Day for Restoration Practitioners, Evaluation and Screening Criteria Workshop, and a Restoration Strategies and Alternative Development Workshop. These workshops are typically organized as "all-hands" events, providing an opportunity for integrating the diverse perspectives and expertise represented by the membership of the Steering Committee, Nearshore Science Team, and Implementation Team. Many workshops have included participation from outside these Nearshore Study teams, helping to broaden the input that has informed the Nearshore Study.

The Nearshore Study team held workshops throughout the Puget Sound in September 2009 that were attended by city and county planning staff, tribal government representatives, non-profit staff, and some consultants. The purposes of these workshops were to: 1) engage the Puget Sound restoration community; 2) provide an overview of the Nearshore Study and its approach to delivering nearshore zone analyses and strategies; and, 3) share the results of the Nearshore Study's Change Analysis, which are useful to a broader audience beyond the Nearshore Study.

8.3.6 NEPA Scoping *

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

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 NEPA

scoping process is designed to provide an early and open means of determining the scope of issues (problems, needs, and opportunities) to be identified and addressed in the environmental impact statement (EIS). The Nearshore Study NEPA/SEPA scoping process was conducted jointly with the WDFW.

An initial scoping meeting was held in October 2001 after completion of the Reconnaissance Phase. However, the NEPA/SEPA scoping process formally commenced on October 26, 2009. A Notice of Intent was published in the Federal Register on October 2, 2009 (Vol. 74, No. 190). The public comment period ran from October 26 to December 10, 2009. The Corps and WDFW held four public meetings in strategic locations around Puget Sound, and placed public notices in prominent sections of 14 major newspapers. The notice was emailed to a broad range of stakeholder groups and posted on the Nearshore Study and Puget Sound Partnership websites. The public scoping meetings were held in the evening to minimize conflicts with standard work schedules. An open house preceded the formal presentation where eight displays and a handout were available, followed by a question and answer period that was recorded and transcribed. The dates and locations of the public scoping meetings were as follows:

- Oct. 26, 2009: Des Moines, Highline Community College (14 people)
- Oct. 28, 2009: Port Townsend, Fort Worden State Park (7 people)
- Nov. 3, 2009: Lacey, Lacey Community Center (15 people)
- Nov. 10, 2009: Mount Vernon, Skagit Station (24 people)

During the comment period, 35 comments were received, of which one was in a letter, nine in comment cards submitted during the scoping meetings, and 25 articulated during the scoping meetings. Comments were evaluated for recurring themes, which were identified as key issues to address in the EIS. The 12 identified themes are listed in Table 8-1.

Following publication of the Notice of Intent, the Corps received a scoping letter from the EPA on December 10, 2009, pursuant to EPA's responsibilities under NEPA and Section 309 of the Clean Air Act. This letter states that Puget Sound recovery is a priority for EPA and that the agency fully supports this effort. The major points in EPA's support letter recommended that the Nearshore Study team do the following: use Valued Ecosystem Components to identify objectives, optimize benefits at multiple scales while developing priorities, consider climate change in project planning, and benefit from lessons learned from other regional coastal restoration initiatives. As identified throughout this document and other supporting documents completed for the Nearshore Study, each of these recommendations has been implemented.

Table 8-1. Summary of Type of Scoping Comments Received

Theme	Number of Comments
General project questions	20
Shoreline management	5
Floodplain development	1
Harvesting energy	1
Water quality	1
Removal of armoring	1
Participation in prioritization of restoration actions	1
Impacts of railroads on nearshore habitats	1
Projects should increase jobs	1
Funding for projects with multiple purposes	1
Global warming should be considered	1
Sustainability of beaches where sediment is brought in	1

8.3.7 Draft EIS Public Comment Period*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

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 Nearshore study, the Draft FR/EIS public comment period formally ran for 90 days beginning in October 2014 and ending in January 2015. The Study team hosted one public hearing in November 2014. In addition to accepting comments during the public hearings, comments were accepted via mail, fax, and email. The Corps recorded and considered all comments received during the comment period. The complete list of comments regarding the Draft FR/EIS and the Corps' responses appears as Appendix H of this Final FR/EIS.

The Corps sent notices of availability to a long list of interested stakeholders, local entities, and all Native American Tribes within the study area with the location of electronic and hard copies. The following is a list of agencies that directly received either an electronic or a hard copy of the Draft FR/EIS for review (other entities received electronic or paper notice of availability):

- Bureau of Indian Affairs
- Environmental Protection Agency
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration – Restoration Center
- National Park Service
- Natural Resource Conservation Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Navy Region Northwest
- Puget Sound Partnership
- Washington Department of Archaeology & Historic Preservation
- Washington Department of Ecology
- Washington Department of Fish & Wildlife
- Washington Department of Natural Resources
- Washington State Department of Transportation

- Washington State Recreation and Conservation Office
- Northwest Indian Fisheries Commission
- The Nature Conservancy
- The Northwest Straits Commission
- Skagit County
- City of Everett
- Port of Edmonds
- Port of Everett
- Orca Straits District – Aquatic Region
- Skagit River System Cooperative
- Orcas Island Library District
- Whatcom County Library
- Skagit County Library
- Sno-Isle Libraries
- King County Library

8.3.8 Environmental Protection Agency Review*

*These headings and all sub-sections therein are required by the National Environmental Policy Act.

The EPA reviewed the Draft FR/EIS in accordance with the EPA's responsibilities under NEPA and Section 309 of the Clean Air Act. Section 309 specifically directs the EPA to review and comment in writing on the environmental impacts associated with all major Federal actions. Review of the Draft FR/EIS considers the expected environmental impacts of the proposed action and the adequacy of the EIS in meeting the procedural and public disclosure requirements of NEPA. The EPA recognizes Puget Sound as an estuary of national significance and has approved the Puget Sound Partnership's Action Agenda as the Comprehensive Conservation and Management Plan of the Puget Sound National Estuary Program.

The EPA states that the Draft FR/EIS responded to their scoping comments and addressed each recommendation. The EPA made further recommendations for the Final FR/EIS and the Corps incorporated much of this into the Final FR/EIS as described in Table 8-2. Full text of the EPA's review letter to the Corps appears in Appendix J, Environmental Compliance.

Table 8-2. The EPA's recommendations for the Final FR/EIS and the Corps' responses on how the information was incorporated.

EPA recommendation	Corps response
Include additional information relating project benefits to ecological outcomes for identified VECs and how benefits may influence trends	The Corps added statements regarding the significance of the resources, including VECs, that would benefit and more detail on how the proposed action would benefit specific fish and wildlife. Data on trends of most of the VECs are still under development and unavailable before finalization of this report.
Optimize benefits at multiple scales and aim for geographic representation of the entire study area, primarily by selecting the alternative that has a greater number of restoration sites with a broader geographic spread and wider range of types of benefits	While the Recommended Plan has fewer sites proposed for construction under this authorization, the Corps and the non-Federal sponsor formulated a comprehensive strategy for restoration at all 36 sites that were under initial consideration at the outset of the conceptual level design phase. These would be constructed under existing authorities or receive further study before authorization and implementation.

Report on lessons learned from other coastal restoration projects, both local and nationwide	One of the technical documents prepared during the Nearshore Study was specifically for the purpose of learning from other large-scale ecosystem restoration projects, titled *Application of the "Best Available Science" in Ecosystem Restoration Project Efforts in the USA* (Van Cleve et al. 2004). While the Corps continues to refer to this document for guidance, the information is not explicitly reiterated in this report, but is available at *www.pugetsoundnearshore.org*. The Corps will seek updated information on lessons learned during the next design phase.
Discuss how climate resiliency factored into the formulation of the final array of alternatives	Climate resiliency of sites was not necessarily a strong criteria for formulation of the final array of alternatives; however, risk of reduction in restoration benefits at each site was analyzed prior to final site selection. Additionally, site features are designed according to the Corps' sea level change analysis as described in section 3.6.5.

8.4 PEER REVIEW

From early in this general investigation, the Puget Sound Nearshore Study team built a rigorous peer review process into all elements – study planning, technical reports, and report development – and plans to continue these practices as an integral component of the plan's implementation. Peer review was designed to meet all pertinent Corps policies (e.g. Engineering Circulars (EC) including EC 1165-2-214). In 2007, the "Peer Review Plan for Feasibility Study of Puget Sound Marine Nearshore Habitat Restoration, WA" (Peer Review Plan; USACE 2007) was developed by the Nearshore Study's Nearshore Science Team and approved by the Corps Ecosystem Restoration Planning Center of Expertise (ECO-PCX). This plan requires external review of the project's technical reports, as well as more comprehensive strategic science and programmatic peer review that includes external review of the sufficiency of science used in the Nearshore Study and the application of science by an independent Strategic Science Peer Review Panel (SSPRP; refer to section 8.4.3).

8.4.1 Corps Review Policy

EC 1165-2-214 identifies specific procedures that must be followed to ensure the quality and credibility of Corps decision documents (USACE 2012). The Nearshore 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 review reports will be submitted to Corps headquarters with the Final FR/EIS.

In accordance with guidelines set by the Corps for planning and ecosystem output models (e.g., ER 1165-2-501 [USACE 1999c] and EC 1105-2-412 [USACE 2011b]), Seattle District has received approval for one-time use of a planning model. The Puget Sound Nearshore Ecosystem Output Model is a regional model developed by members of the Nearshore PDT and the NST.

The model was used to generate net benefit scores for the array of actions under consideration. A documentation report (Appendix G) that explains the model has undergone peer review by the SSPRP. The model review plan was submitted to the ECO-PCX in June 2012 and received one-time use approval in November 2012.

8.4.2 Technical Report Peer Review

Consistent with the Peer Review Plan, primary program documents developed during the Nearshore Study have undergone peer review. Typically for draft technical reports, two to four subject matter experts outside of the project are engaged as anonymous reviewers by a member of the PDT, who provides the reviewers' comments to the report's primary author. Following revisions to address comments, the technical report is assigned a document number and published on the Nearshore Study's website. On the website, supporting documents used to inform the Nearshore Study, but did not receive those peer review procedures, are clearly distinguished from peer-reviewed technical reports.

8.4.3 Strategic Science Peer Review Panel

Integral to the Nearshore Study, a continuous peer-review process provides guidance to ensure that the Nearshore Study is following the best available science. To provide a broad overview of application of scientific principles and information in completing the Nearshore Study, the NST recommended that potential panel members have experience in large-scale coastal restoration actions and the following disciplines be explicitly represented in external review:

- coastal geomorphology
- estuarine/coastal ecology
- restoration planning, monitoring, and assessment
- landscape ecology
- coastal/estuarine oceanography/sediment transport
- social science

The SSPRP convened in the summer of 2008 to provide independent review and input to the Nearshore Study. In convening the SSPRP, the NST and PMT identified potential panel chairpersons. The SSPRP Chair was selected based on international recognition for scientific excellence and extensive experience in other national ecosystem restoration programs. SSPRP members were selected based on each person's identified area of expertise, in consultation with the SSPRP Chair. The role of the SSPRP is based on the Nearshore Study's Peer Review Plan with modifications based on recommendations from the SSPRP and experience from other large-scale restoration programs.

Procedures and schedules for the SSPRP review are coordinated through the Chair. The SSPRP Chair communicates annually with the rest of the Panel to determine which Nearshore Study

documents were due for review and who among the Panel members would take the lead for each, based on their expertise. In addition to review of the program's application of science, the SSPRP reviewed complex program documents, including the Ecosystem Output Model and the Feasibility Scoping Meeting submittal package. Drafts were distributed to the Panel members with at least two months allowed for review; the Chair coordinated the review summary in all cases, usually with a conference call among the SSPRP members. Additional full-group reviews were provided during periodic on-site, multi-day SSPRP programmatic workshops with the Nearshore Science Team and Project Management Team, which included attendance by other members of the Nearshore Study team, such as the Steering Committee. These comprehensive SSPRP workshops were convened in June 2008, May 2009, and November 2011.

9 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 Puget Sound Nearshore 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 $451,627,000 (March 2016 price level), which includes monitoring costs of $1,090,000 and adaptive management costs of $5,307,000. Operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) expenses are estimated at $863,000 per year. The Federal portion of the estimated first cost is $293,558,000. The non-Federal sponsors' portion of the required 35% cost share of total project first costs is $158,069,000. The LERRD estimate exceeds the 35% non-Federal cost share for restoration features by $3,420,000 and the value of these excess LERRD may be reimbursed to the non-Federal sponsor subject to the availability of funds. However, this situation is unlikely to be realized because the escalated, fully-funded cost estimate does not reflect a LERRD value that exceeds the 35% non-Federal cost share. The non-Federal partners shall agree, prior to implementation, to perform the following items of local cooperation:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:
    1. Provide the required non-federal share of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs;
    3. 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;
    4. Provide, during construction, any funds necessary to make its total contributions equal to 35 percent of total project costs.
b. Provide work-in-kind during final design and construction as well as providing the post-construction monitoring. The value of LERRDs needed for the project are credited against the non-federal sponsors' cost-sharing requirement;

c. 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 funds verifies in writing that such funds are authorized to be used to carry out the project;

d. 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 that might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

e. 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;

f. 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;

g. 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;

h. Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsors own or control for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

i. 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;

j. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 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;

k. 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.);

l. 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 sponsors with prior specific written direction, in which case the non-federal sponsors shall perform such investigations in accordance with such written direction;

m. Assume, as between the federal government and the non-federal sponsors, 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;

n. Agree, as between the federal government and the non-federal sponsors, that the non-federal sponsors shall be considered the operators 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

o. 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 a proposal for construction authorization at three sites across Puget Sound (Duckabush River Estuary, Nooksack River Delta, and North Fork

Skagit River Delta). While the recommended plan includes restoration at these three sites, the National Ecosystem Restoration (NER) Plan is a 36-site master plan intended to restore a more diversified scope or projects to be implemented under various restoration authorities and partners. This 36-site plan reasonably maximizes ecosystem restoration benefits and restores over 8,000 acres across all seven Puget Sound sub-basins. The NER Plan includes 16 river delta sites, 10 coastal inlet sites, 6 barrier embayment sites, and 4 beach sites. Of the 36 sites included in the NER Plan, there are nine projects recommended for additional study. These sites and their estimated costs including $3,000,000 for feasibility plus conceptual construction cost estimated at the March 2016 price level are as follows: Dugualla Bay at $88,355,000, Everett Marshland at $296,605,000, Telegraph Slough at $256,124,000, Chambers Bay at $298,002,000, Big Beef Creek Estuary at $37,376,000, Tahuya River Estuary at $30,305,000, Lilliwaup River Estuary at $36,994,000, Big Quilcene River at $37,600,000, and Snohomish River Estuary at $126,593,000. Every effort should be made to pursue authorization at these additional sites.

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
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12 ANNOTATED BIBLIOGRAPHY

These documents are available upon request by sending an e-mail request to *pugetsoundnearshore@dfw.wa.gov* except for those whose distribution is prohibited. When an electronic version is available, a hyperlink to the document will be included below. All of these documents are incorporated by reference according to 40 CFR 1502.21 except for those denoted by an asterisk (*) as they are not available for public distribution, or in the cases of appendices that are summarized herein.

Puget Sound Nearshore Ecosystem Restoration Project Technical Reports

Principles for Strategic Conservation and Restoration
This report summarizes principles of landscape ecology and conservation biology that are applicable to the conservation and restoration of nearshore ecosystems in Puget Sound and are intended to guide the prioritization of sites and actions by the Nearshore Study team and others. The result is 11 principles derived from the literature organized into three hierarchical scales: 1) Overarching Principles; 2) Landscape Level Principles; and 3) Site-Specific Principles.
Available at:
www.pugetsoundnearshore.org/technical_papers/conservation_and_restoration_principles.pdf

Historical Change and Impairment of Puget Sound Shorelines: Atlas and Interpretation of Puget Sound Nearshore Ecosystem Restoration Project Change Analysis
This report is a comprehensive, spatially explicit analysis (Change Analysis) of net changes to nearshore ecosystems of Puget Sound—its beaches, estuaries, and deltas—since its earliest industrial development. These quantified changes in the structure of Puget Sound's shorelines are indicators of qualitative change to ecosystem processes. Because historical documentation of nearshore ecosystem processes does not exist per se, we used the observed physical changes to the shoreline, Nearshore Study conceptual models, and other sources of understanding about the relationship among nearshore ecosystem processes, structures, and functions to interpret the levels and types of impairment of nearshore ecosystem processes. Our approach was to systematically quantify historical change in the physical structure of Puget Sound's shorelines over the past approximately 150 years, between the earliest land surveys of the General Land Office and U.S. Coast and Geodetic Survey (1850s–1890s) and present conditions (2000–2006).

Historical change was analyzed in four categories: Tier 1) Landform Transition, changes in landform class, either among natural geomorphic classes or to classifications of artificial or absent; Tier 2) Shoreline Alterations, changes in historically documented attributes such as wetlands or current anthropogenic modifications (considered stressors) along the shoreline; Tier 3) Adjacent Upland Change, anthropogenic changes within 200 meters of the adjoining uplands; and Tier 4) Watershed Area Change, anthropogenic changes in the drainage area. The four categories of nearshore change (tiers) were related to shifts in the benefits of natural nearshore ecosystems to humans and their communities. The results of this analysis can be used to inform

restoration and preservation planning about the types, extent, and consequences of changes to Puget Sound's shoreline.
Available at: *www.pugetsoundnearshore.org/technical_papers/change_analysis.pdf*

Implications of Observed Anthropogenic Changes to the Nearshore Ecosystems in Puget Sound
This report by the Nearshore Study Nearshore Science Team presents a synthesis of the most significant physical changes to the nearshore ecosystems of Puget Sound and implications of these changes to ecosystem functions, goods, and services. Documented historical changes to the shoreline environment of Puget Sound have caused widespread losses in connectivity, increased fragmentation of the landscape and simplification of nearshore landscapes. These impacts have disrupted many nearshore ecosystem processes that support important species and have impaired the system's capacity to support biological diversity and production.
Available at:
www.pugetsoundnearshore.org/technical_papers/implications_of_observed_ns_change.pdf

Strategic Needs Assessment: Analysis of Nearshore Ecosystem Process Degradation in Puget Sound
This report characterizes the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identifies the potential causes of observed ecosystem degradation, and assesses which of the identified problems most need to be addressed through restoration and protection actions. To support this strategic needs assessment, a spatially explicit evaluation framework was created and applied to characterize the extent to which the observed distribution of stressors has degraded each of the 11 nearshore ecosystem processes evaluated.
Available at:
www.pugetsoundnearshore.org/technical_papers/strategic_needs_assessment_final.pdf

Strategies for Nearshore Protection and Restoration in Puget Sound
This report, commonly called the "Strategies Report" integrates change analysis and estimated process degradation, under a simple restoration and protection planning model. This model offers a framework for the management of Puget Sound nearshore ecosystems. We identify a set of delta, beach, barrier embayment and coastal inlet sites. Sites differ in their historical potential to provide ecosystem services. Restoration and protection planning should consider the operation of critical ecosystem processes at the site scale. The intensity and character of site degradation both indicates the potential for restoration, but creates risk in that restoration efforts may be undermined by degradation of critical ecosystem processes. The development of landscape strategies and conservation actions can be informed by these large-scale assessments. We provide suggestions for incorporating Nearshore Study data into restoration planning. Our framework and assessments point to groups of large complex sites, where there may be exceptional opportunities for large-scale ecosystem restoration or protection.

Available at:
www.pugetsoundnearshore.org/technical_papers/psnerp_strategies_maps_lowres.pdf

U.S. Fish and Wildlife Service Reports

This is a series of four documents produced by the USFWS with contractor support to supplement Nearshore Study conceptual design work and includes the following:

PSNERP Strategic Restoration Conceptual Design Preliminary Environmental Contaminants, Cultural Resource, and Endangered Species Site Evaluations.
This report provides baseline information on environmental contaminants, cultural resources, endangered species and conservation measures for 36 candidate restoration sites under consideration by the Nearshore Study team. Environmental Site Assessment Level 1 Survey Checklists were also completed for each of the 36 sites.

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington, Task 1. Literature and Data Review and Synthesis*
This report presents the results of cultural resource record/literature searches for 36 candidate restoration sites under consideration by the Nearshore Study team. An assessment of the potential for cultural resources within each project area is made based on a review of the environmental, cultural, and archaeological data, and recommendations are provided on where future archaeological efforts should be made for each of the 36 action areas. By law, sensitive cultural resource information is not available for public release.

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington, Task 2: Historic Context of Agricultural Dikes.
This report is a regional-scale historic context of late 19th and early 20th century agricultural development within the Puget Sound region of NW Washington. This effort documents the history of development of dikes built in the region, and proposes evaluation criteria to use as a management tool for the USFWS and others to use for compliance with NHPA Section 106.

Cultural Resources Field Inventory for 15 Action Areas within the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington*
This presents the findings surface surveys and subsurface investigations concentrated on project components within areas previously determined to have high to moderate probabilities for cultural resources. The purpose of the inventory was to provide (1) descriptions of cultural resources in the area of potential effect (APE) for Nearshore Study undertakings, (2) determinations concerning the eligibility of cultural resources to the National Register and the Washington Heritage Register (WHR), and (3) recommendations on how to avoid or mitigate impacts to historic properties. This report was completed for subset of the 36 candidate restoration sites, and only on lands where access had been granted by the landowner. By law, sensitive cultural resource information is not available for public release.

PUGET SOUND NEARSHORE
ECOSYSTEM RESTORATION

APPENDIX A

PUGET SOUND NEARSHORE IMPLEMENTATION STRATEGY

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps
of Engineers
Seattle District

US Army Corps of Engineers.

Washington Department of FISH and WILDLIFE

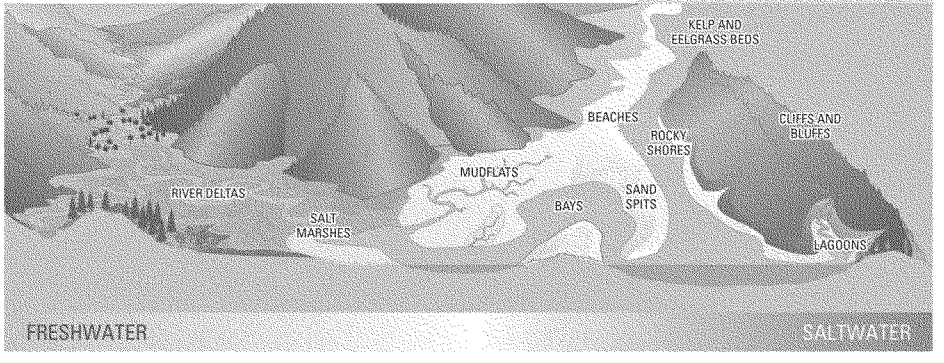
Puget Sound Nearshore Ecosystem Restoration Project

Background

- The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is o large scole restorotion initiative designed to remove man-mode stressors in the nearshore zone of Puget Sound and restore natural, self-sustaining processes that are integral to supporting the structures ond functions that provide ecosystem goods and services.
- The nearshore zone is the transitional area between terrestrial and aquatic (saltwater) ecosystems. It is constrained by geologic features rooted in Puget Sound's formative glacial history. Mountainous uplands transition rapidly to deep saltwater areas resulting in a narrow band of nearshore habitot at the shoreline of Puget Sound.
- The nearshore zone is a biologically rich and productive area supporting a diversity of species throughout the food web including concentrations of waterfowl, shorebirds and raptors; abundant shellfish; marine mammals; and some of the largest salmon runs in the lower 48 states. The nearshore zone provides commercial, recreational and aesthetic benefits to humans that suppart our livelihood and quality of life.
- The nearshore is also appealing to humans with 67% of Washington's population living in a county that touches Puget Sound. Human development within the nearshore zone and adjacent uplands has resulted in a diverse array of man-made stressars.
- Within the nearshore, stressors that include diking, dredging, filling, and armoring, have displaced, destroyed, or modified nearshore ecosystems.

Six major changes to the physical characteristics of the nearshore have been identified through PSNERP data analysis.

1. Large river deltas have significantly reduced in size (27% decrease in length due to tidal barriers and armoring)
2. 35% of historical coastal embayments have been lost by being filled in or disconnected by tidal barriers
3. Sediment input has been disconnected at beaches/bluffs (over 25% of the shoreline is armored)
4. 74% of tidal wetlands surrounding the shores of Puget Sound have been lost
5. The Puget Sound shoreline has become shorter and more artificial decreasing in length by 15%
6. Many shorelines are experiencing multiple stressors and cumulative impacts



Importance



The Puget Sound in Washington State contains 2500 miles of shoreline

The shoreline is divided into geomorphic segments called landforms. Priority landforms for restoration efforts, as identified in the Change Analysis technical document include:

- river deltas
- barrier embayments
- coastal inlets
- beaches/bluffs

The diversity of landforms is driven by different underlying processes that create and maintain these landforms.

The mosaic of landforms support ecosystem functions, goods and services valued by humans including ecological, economic, cultural, spiritual, and aesthetic values.

Restoration measures applied across the diversity of landforms will contribute to ensuring a healthy Puget Sound.

- Puget Sound and its adjacent waters support the largest area of remaining estuarine wetlands on the West Coast, exceeding the combined total area of Columbia River and San Francisca Bay estuarine wetlands by over 30%. Because of its size, tidal exchange, and freshwater inputs, Puget Sound supports more than twice the primary productivity of Chesapeake and San Francisco bays combined.

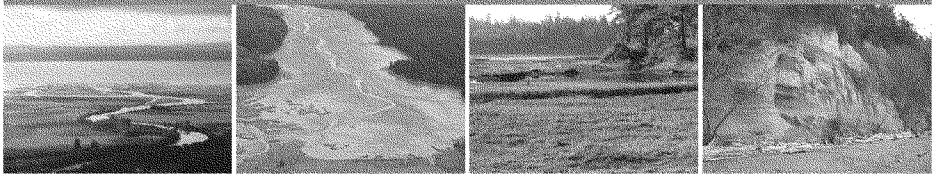
- Recognizing its uniqueness, the U.S. Environmental Protection Agency (EPA) designated Puget Sound as an "Estuary of National Significonce" in 1988.

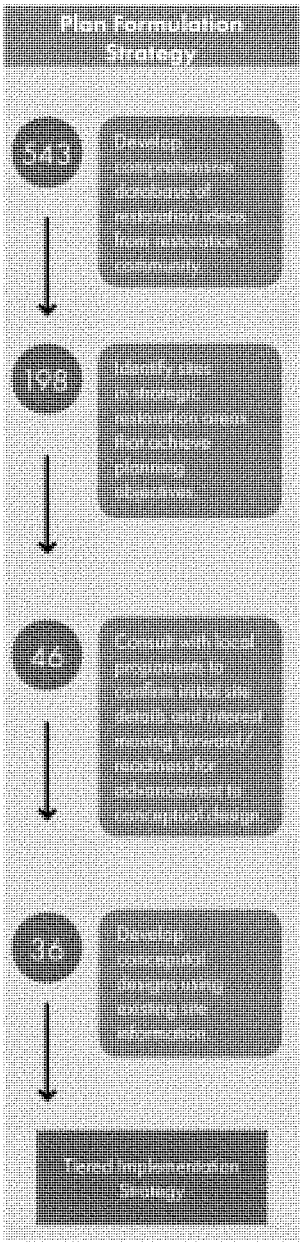
- The Puget Sound Action Agenda is the federal and state roadmap for restoring the health of Puget Sound by 2020. Proposed restoration by PSNERP is an integral component to achieving Action Agenda recovery targets. The Action Agenda has been approved by EPA as the Comprehensive Conservation and Management Plan for Puget Sound under the EPA's National Estuary Program and has also been endorsed by the Puget Sound Federal Caucus (which includes the Corps of Engineers).

- Nearshore restoration actions that improve hobitat function are critical to the recovery and protection of tribal treaty right resources, such as fish and shellfish, in Puget Sound. US v WA and sub-proceedings guaranteed Treaty Tribes 50% of salmon (Boldt decision) and shellfish resources (Rafeedie decision), and confirmed the value of habitat in order to maintain harvestable populations.

- Over a dazen species including fish, mammals and birds, are currently listed as federally endangered or threatened under the Endangered Species Act are dependent on the ecosystems of Puget Sound and either directly or indirectly on the Puget Sound Nearshore.

RIVER DELTAS | COASTAL INLETS | EMBAYMENTS | BEACHES/BLUFFS

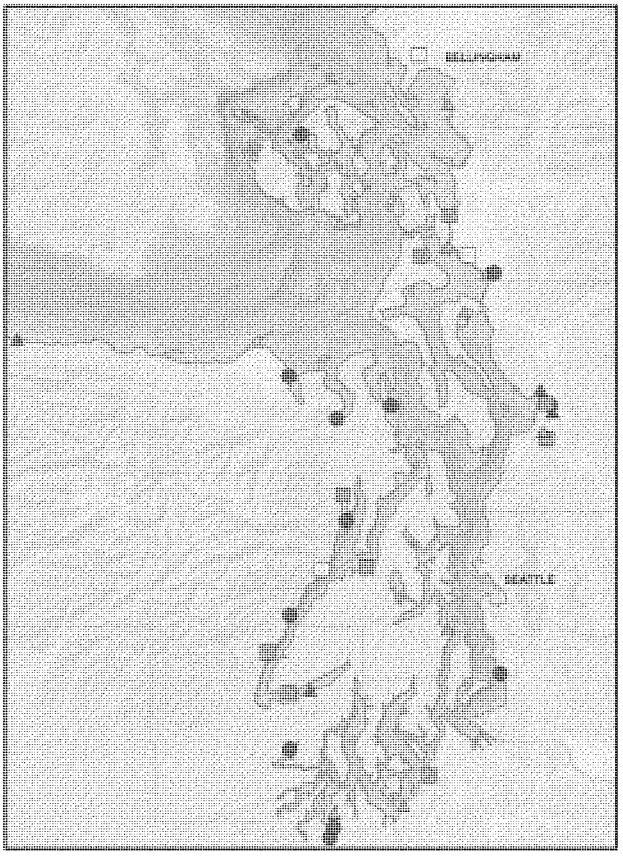




Implementation Strategy

PSNERP's planning objectives include:

- Restore the connectivity and size of large river delta estuaries.
- Restore the number and quality of coastal embayments.
- Restare the size and quality of beaches and bluffs.



Tiered Implementation Strategy

- Section 544 (Puget Sound and Adjacent Waters) existing authority, $5M Federal per project limit
- Section 206 (Aquatic Ecosystem Restoration) existing authorities, $10M Federal per project limit
- PSNERP Chief's Report: 3 sites to be finalized for construction authorization
- PSNERP Chief's Report: 9 sites to be authorized for continued feasibility study
- Projects to be completed by others based on PSNERP design and analysis

Implementation Approach

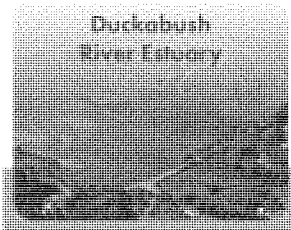
Section 544:
Quilcene Estuary
Spencer Island
Twanoh Beach
Twin Rivers

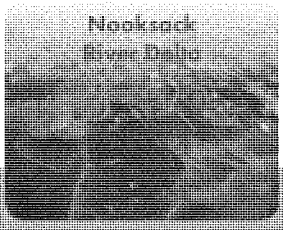
Section 206:
Chuckanut Estuary
Deepwater Slough
Everett Riverfront Wetland
Harper Estuary
Irrigation Bay
McDinn Island
Sequalitchew Creek
WDNR Budd Inlet Beach

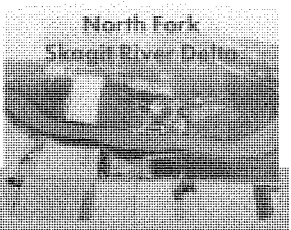
PSNERP Chief's Report (3 sites):
Duckabush River Estuary
Nooksack River Delta
North Fork Skagit River Delta

Projects to be completed by others (12 sites)

PSNERP Chief's Report Additional Study (9 Sites):
Big Beef Creek Estuary
Big Quilcene River
Chambers Bay
Dugualla Bay
Everett Marshland
Lillliwaup Estuary Restoration
Snohomish Estuary Main Stem
Tahuya River Estuary
Telegraph Slough







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PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX B

ENGINEERING APPENDIX

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps
of Engineers
Seattle District

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Section 1 – Duckabush River Estuary

Section 1: Duckabush River Estuary

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1-1 GENERAL – DUCKABUSH RIVER ESTUARY

1-1.1 Overview of Restoration Site

The Duckabush River is one of several major river systems that drain the east slope of the Olympic Mountains to Hood Canal. The broad river delta fans out into Hood Canal on the south side of the Black Point Peninsula at approximately Mile 310 of Highway 101 (Figure 1- 1-1). The estuary contains salt marshes, eelgrass beds, and extensive mud and gravel flats that are productive shellfish beds. The Duckabush Estuary is also home to harbor seals, bald eagles, and regionally significant winter waterfowl.

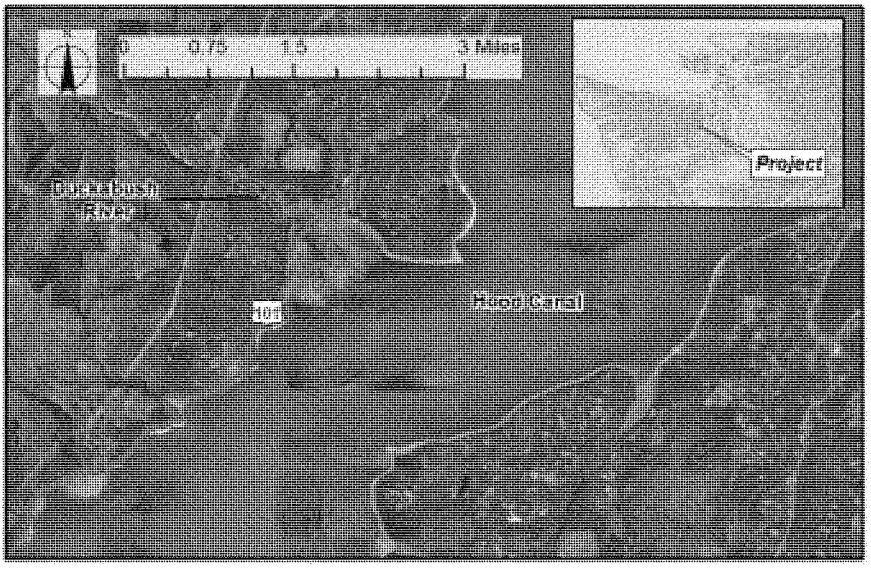


Figure 1- 1-1. Duckabush River Estuary and vicinity.

The Duckabush River is contained within a single channel through the site before emptying into the marsh and submerged marsh outboard of the site. The historic northern arm of the river has been blocked, is aggraded, and is a dead-end channel in the middle portion of the site. The Duckabush River Estuary was bisected by an early roadway and bridge that spanned the two distributary channels. A portion of the roadway, dikes, and abutments remain in place today. The majority of this infrastructure was removed and replaced in 1934 with two separate bridges as part of the construction of Highway 101. This highway cuts across the intertidal river delta and estuary wetland complex, spanning the main channel and a former distributary channel via two bridges. The Highway 101 bridges impact the Duckabush estuary, disrupting tidal circulation and impeding fish access to productive salt marsh and slough habitats. These hydraulic constrictions along with fill within the estuary have led to decline in mudflats and salt marsh. In addition, training berms are in place at the southern arm of the Duckabush distributary channel, just upstream of the Highway 101 crossing, to control lateral movement of the channel and prevent river flows into historical distributary channels. These berms severely restrict lateral connectivity with tidal channels and salt marsh habitat.

From conversations between the Washington Department of Transportation (WSDOT), the Corps and the Washington Department of Fish and Wildlife (WDFW) about the Duckabush bridges, they are both listed by WSDOT as functionally obsolete, but neither are on any list for replacement or repair neither due to their obsolescence nor for chronic environmental deficiencies. Since SR 101 is not on the Interstate System and there is no anticipated involvement from the Federal Highway Administration (FHWA).

The Duckabush Estuary is home to trumpeter swans, bald eagles, and regionally significant winter waterfowl. Harbor seals haul out in this location throughout the year and pupping occurs in the winter. The extensive mud and gravel flats are productive shellfish beds. Salt marshes and eelgrass beds characterize the upper and lower intertidal and subtidal areas, respectively. Herring use this eelgrass for spawning. The Duckabush River hosts four Endangered Species Act (ESA) listed species of salmon: Hood Canal summer chum, Puget Sound steelhead, Coastal/Puget Sound bull trout, and Puget Sound Chinook salmon. The wild Chiuook run is nearly extirpated from this river.

The proposed restoration would restore tidal and riverine hydrology to 38 acres of the Duckabush River Delta. This action would allow for natural habitat forming processes including sediment and detritus exchange, tidal channel formation, freshwater input, and tidal flushing within the delta.

1-2 HYDROLOGY AND HYDRAULICS

The Duckabush River Estuary site lies along Hood Canal on the east side of the Olympic Peninsula. The headwaters of the 20-mile Duckabush River are located on the eastern slope of the Olympic Mountains on the Olympic Peninsula. The 67 square-mile basin is comprised of 95% forested land, most of which is located in the National Park or National Forest boundary. The river is characterized by a steep gradient (150 feet per mile, on average) with average precipitation in the basin is approximately 113 inches per year, with a 2-year event equaling 3.5 inches per hour. For the last mile, the river flattens quickly and flows through a 1960's development called the Olympic View Tracts before it terminates in Hood Canal just south of the town of Brinnon. The gradient through this section is approximately 40 feet per mile and much of the river in this reach is tidally influenced. In a typical water year, the Duckabush River has a dual peak, with the largest flows in the fall and a lesser peak during the spring snow melt. Upstream of the estuary, residents in Olympic View Tracts have constructed private revetments along the banks of the river (USACE 2003).

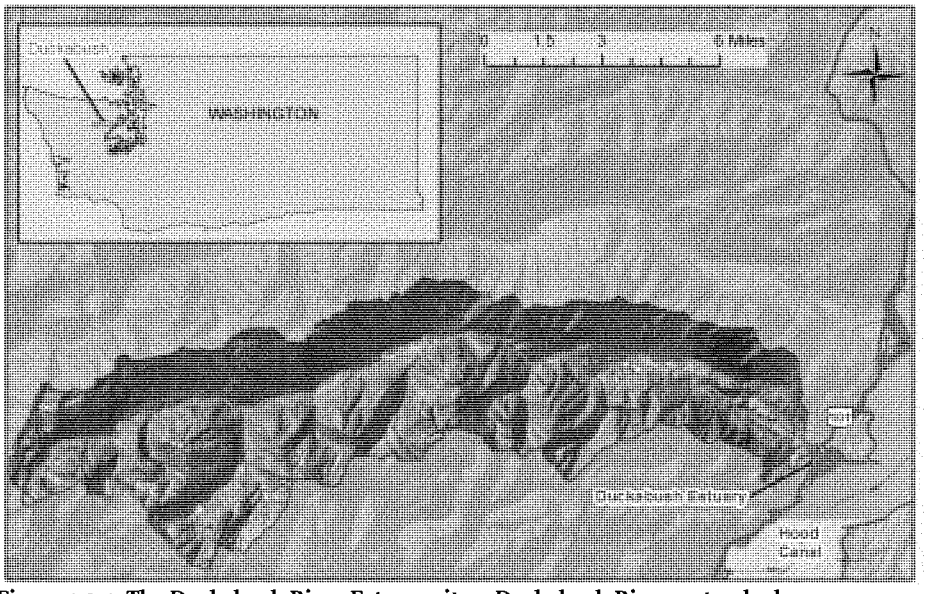


Figure 1-2-1. The Duckabush River Estuary site – Duckabush River watershed

The site is located in the estuary of the Duckabush River. Figure 1-2-1 shows a map of the watershed, including the Duckabush River, Hood Canal and the local drainages that affect the Duckabush site. On the north side of the estuary there is a small catchment of 0.5 square miles that terminates in a fish-bearing culvert at Highway 101. The construction plan calls for removal of this culvert and rerouting of the catchment drainage to the restored estuary.

The hydraulics and hydrology for all restoration sites in the Puget Sound Nearshore Ecosystem Restoration Project were evaluated using an area of potential hydraulic effects specific to the construction requirements for each particular site. The upstream and lateral limits of the area for this site were established using 100-year Base Flood Elevations (BFEs) derived from a combination of Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) (FEMA 1982).

According to the 1% Annual Exceedance Probability (100-year) BFE as determined by the effective FEMA flood insurance mapping for unincorporated areas of Jefferson County, community 530069 (revised 1982), the entire site lies within the 100-year floodplain. Figure 1-2-2 shows the area of potential hydraulic effects for the Duckabush site. Downstream and seaward limits are based on changes in shoreform type and best professional judgment.

The BFE at the site depends primarily on coastal flooding from storm surge that originates on the West side of the Olympic Peninsula. According to the FEMA FIS, most of the very high stillwater levels were not associated with high wind velocities and were instead associated with the dynamics of a Pacific Ocean surge tracking into Puget Sound. The coastal BFE is 15.3 feet (NAVD88) which extends the stillwater surface upstream of the current Highway 101 location. The Duckabush River will have the same tailwater elevation for the base flood both with and without the project. The upstream end of hydraulic effects may extend above the BFE since the increased conveyance from bridge removal will likely reduce upstream water levels for high rainfall flow events that occur without the coastal flooding.

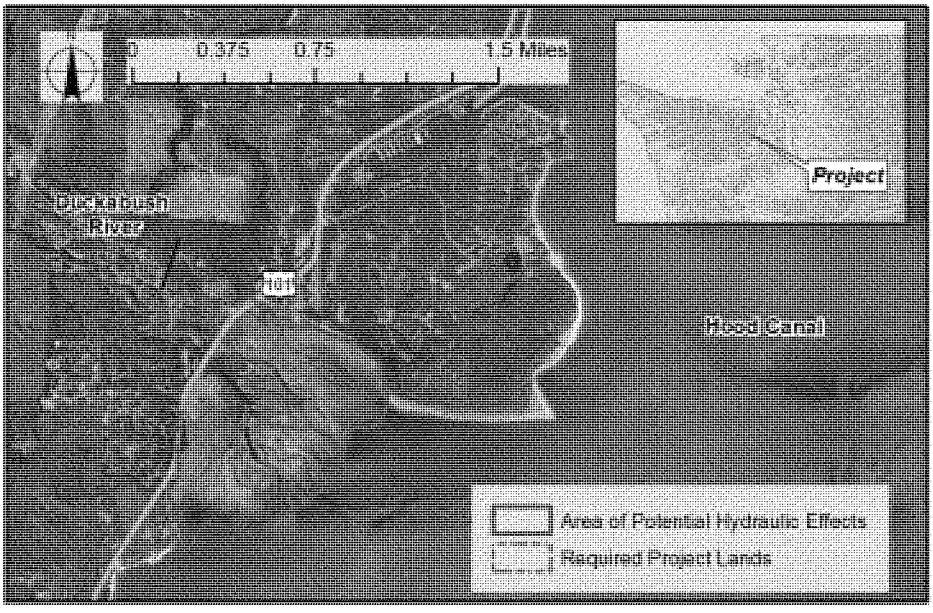


Figure 1-2-2. The Duckabush River Estuary: Area of potential hydraulic effects.

The Ecosystem Output Model (EOM), described in Appendix G utilized an area of restored process determined as follows:

The upland portion of each analysis area was delineated to ensure that the area included all stressor distributions within defined buffer distances from the shoreline. In the aquatic areas, the shape of the analysis area was determined by a combination of:

- The area provided initially by the design team and the associated parcel map for the proposed action
- Ensuring an area encompassed all delineated tidal wetlands
- For any analysis area that extended through an aquatic area, boundaries were established approximately perpendicular to the shoreline orientation where the upland meets the shoreline.

The area of restored process at Duckabush is shown in Figure 1-2-3 as 38.1 acres. For more information, please refer to Puget Sound Nearshore Ecosystem Restoration Project Fish and Wildlife Coordination Act Section 2(b) report in Appendix J, Environmental Compliance Documentation.

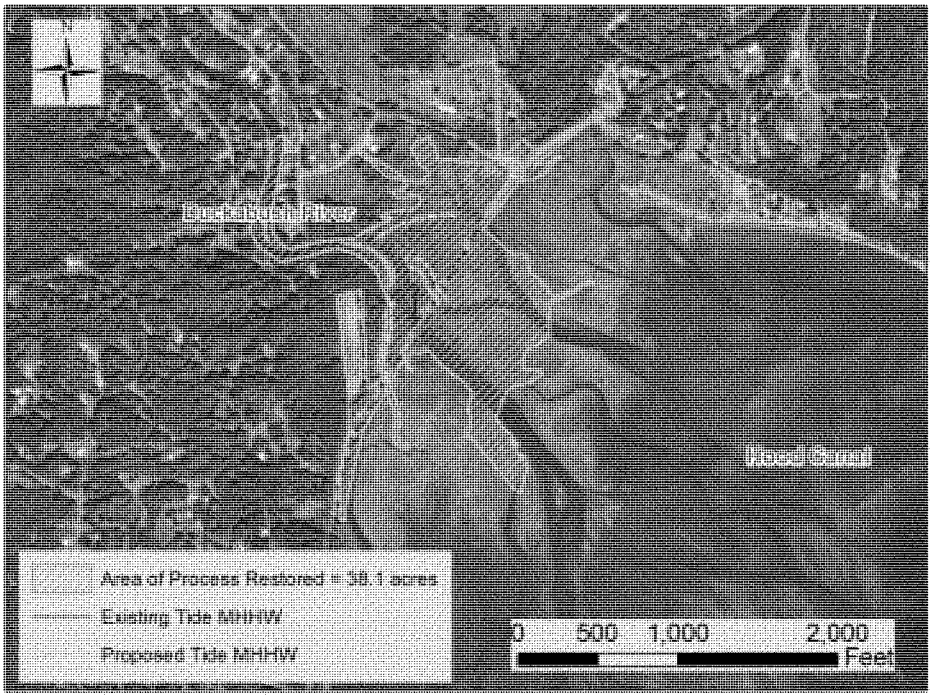


Figure 1-2-3. Area of process restored used in ecosystem output model at the Duckabush River Estuary.

1-2.1 Functional Design Requirements

This section describes the hydrologic and hydraulic setting for the site and the intended hydraulic consequences of the design features.

1-2.1.1 Consequences of flows exceeding discharge capacity of the project

The purpose of the work at this site is to remove Highway 101 roadway embankment and bridges that impact the Duckabush estuary, disrupting tidal circulation and impeding fish access to productive salt marsh and slough habitats. This site does not include water control facilities other than roadway drainage culverts. Should discharges exceed the design capacity of the culverts there would be a potential for roadway overtopping.

1-2.1.2 Project-induced changes obligating mitigation

No compensatory mitigation is included for this site as none is required. Temporary fill for construction in the estuary will be designed according to conservation measures provided in the Biological Opinion from the National Marine Fisheries Service to minimize impacts to aquatic species. The restoration actions 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 based on the specific effects of the project.

Mitigation for any change to or removal of the Duckabush Bridge may be required due to its listing on the National Register of Historic Places. The Corps is coordinating a Programmatic Agreement for compliance with Section 106 of the National Historic Preservation Act. If it is determined that the project will have an adverse effect on any significant structures, including the Duckabush Bridge, the Corps will avoid, minimize, or mitigate following Section 106 procedures and stipulations in the Programmatic Agreement.

1-2.1.3 Discharge-frequency relationships

The site is located on the Duckabush River near Brinnon, Washington. Discharges at this location are taken from the effective FEMA FIS (1982) and are based on USGS gage data from Gage 12054000 with records from 1911 and 1938 through 1982. USGS gage has data available from 1938 through the current year. Annual Exceedance Probability (AEP) along with discharge is shown in Table 1-2-1. The hydrology for the Duckabush River will be reviewed and updated in PED.

Table 1-2-1. Peak Discharge – Frequency predictions for Duckabush River at Brinnon (FEMA 1982).

Location	10% AEP (cfs)	2% AEP (cfs)	1% AEP (cfs)	0.2% AEP (cfs)
Duckabush River Near Brinnon	6,760	8,870	9,770	11,900

1-2.1.4 0.2% Annual Exceedance Probability (500-year return interval) flood

The area of potential hydraulic effect for the Duckabush Estuary is dominated in the lower reaches by storm surge from Hood Canal. The 0.2% AEP coastal base flood elevation of 15.6 feet as reported by FEMA (1982) is very close to the 1% AEP (15.3 feet). Since work at the site involves the construction of a bridge, the 0.2% AEP will have to be re-evaluated during PED.

1-2.1.5 Stage-discharge relationships

Stage discharge relations are reported in the FEMA FIS (1982) are shown in Table 1-2-2. In order to update the forecast for stage discharge relations a coastal flooding analysis will be conducted in PED. This can be combined with a 1D - 2D HECRAS model of the upstream reach of the Duckabush River to evaluate any effects that may occur under various flow scenarios. While a hydraulic model is not needed for purposes of flood reduction, the project design must take in to account possible impacts that could occur during high flow events (bankfull or greater) that don't include coastal flooding. The FEMA FIS assumes the coastal BFE as a tailwater condition. More frequent flood events on the Duckabush River can result from storm events without coastal flooding. For a riverine flood with tailwater at Mean Lower Low Water, the increased conveyance at the Duckabush River crossing may result in substantially less backwater and higher flow velocities upstream. The riverine model will be used to ensure that the project design will not cause headcutting or scour at revetments upstream or unwanted sedimentation in the estuary. It will also be used to ensure that piers and abutments are sized and aligned so as to minimize scour in bankfull flood events.

Table 1-2-2. Stage-discharge relations as shown in the effective FEMA Flood Insurance Study for the Duckabush site (FEMA 1982)

Location	10% AEP Stage (feet NAVD88)	2% AEP Stage (feet NAVD88)	1% AEP Stage (feet NAVD88)	0.2% AEP Stage (feet NAVD88)
Duckabush River near Brinnon	14.9	15.2	15.3	15.6

1-2.1.6 Flow duration

Flow duration data are available from daily discharge readings near Brinnon (USGS 12054000) for the period between July, 1938 and the present. An unsteady flow analysis or flood flow routing will not likely be required for this site since flooding is governed by the static coastal flood elevation.

1-2.1.7 Flood inundation boundaries and flood stage hydrographs

The current flood inundation boundaries as reported for the 1% AEP (100-year) flood event in the Jefferson County FEMA Flood Insurance Study are shown in Figure 1-2-4. For the 1% AEP event, the Duckabush River floods from valley wall to valley wall at the site.

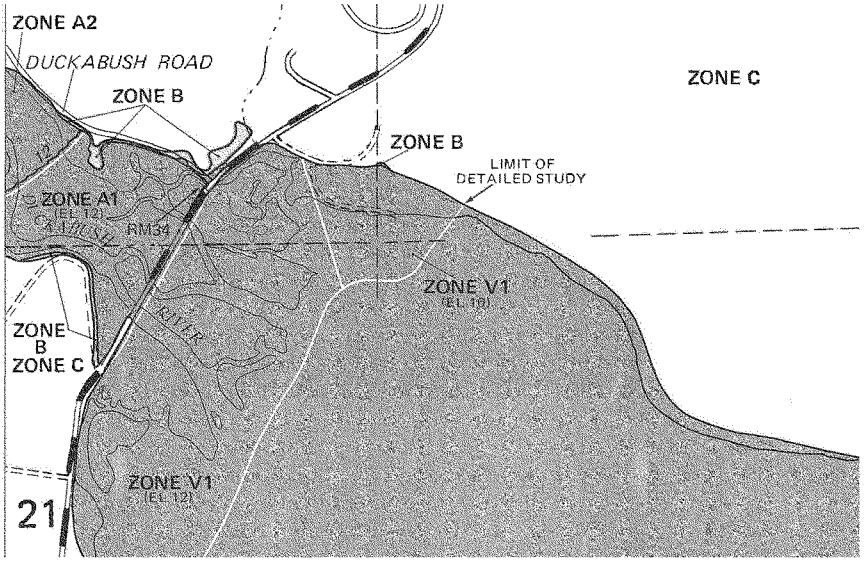


Figure 1-2-4. Effective FEMA 100-year flood zone as adapted from Flood Insurance Rate Map (FIRM 5300691245B) (FEMA 1982) (Elevations in NGVD29; NGVD29 + 3.57 feet= NAVD88). Note that inundations have been rounded to the nearest foot on this map.

1-2.1.8 Reservoir yields

No reservoirs are planned as part of this site.

1-2.1.9 Risk and uncertainty analysis for sizing of the project under study

Channel sizing:

Channels will be excavated to equilibrium dimensions as described in the *Applied Geomorphology Guidelines* (Attachment B). Equilibrium channel top widths for an estuary of this size are around 50feet, with depths between 5 and 10 feet below existing grade. A channel depth of 10 feet would allow for some infilling of the channels without impacting the performance of the restoration. The way in which the new distributary channels will evolve has not been analyzed in the Feasibility phase, but the concept of natural evolution, coupled with equilibrium channel design in PED, minimizes risk because there are no specific discharge requirements for the new channels beyond providing an initial equilibrium design..

Sea Level Change

The Duckabush River Estuary is located in the Hood Canal Sub-basin of Puget Sound. Sea Level Change (SLC) calculations for the Hood Canal Sub-basin are based on the Port Townsend tide gauge and are calculated using the guidance in ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, and ETL-1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation (USACE 2013, 2014). Table 1-2-3 shows the range of sea level change projections for the 50-year project life as well as the 100-year horizon assuming a project start date in 2020. Changes are referenced to 1992, which is the midpoint of the most recent National Tidal Datum Epoch as established by NOAA. The high rate calculations indicate a sea level rise of 2.3 feet in 50 years after project start and a rise of 6.4 feet after 100 years .

The largest risk associated with sea level change at this site is the displacement of habitat upstream, with vegetated marshes becoming intertidal habitat and intertidal habitat becoming sub-tidal habitat. Tidal marshes can adapt to sea level change by building elevation to keep pace with the rising water levels, but this requires an adequate supply of sediment and/or organic matter accumulation. Future studies should include a sedimentation analysis to determine what impact the restoration will have on sedimentation rates and if there is sufficient sediment accumulation to keep pace with the projected sea level change. The sedimentation analysis will be used to fine tune initial channel design and to assess the anticipated environmental benefits from the project over the design life.

Table 1-2-3. Projected Sea Level Change (feet) Port Townsend (Gauge 9444900). Source: USACE Sea-Level Change Curve Calculator (2015.46).

Year	Low (feet)	Intermediate (feet)	High (feet)
1992	0	0	0
1995	0.02	0.02	0.02
2000	0.05	0.06	0.08
2010	0.12	0.15	0.24
2020	0.18	0.25	0.47
2030	0.25	0.38	0.78
2040	0.31	0.52	1.17
2050	0.38	0.68	1.62
2060	0.44	0.85	2.16
2070	0.51	1.05	2.76
2080	0.57	1.26	3.44
2090	0.64	1.49	4.2
2100	0.7	1.74	5.03
2110	0.77	2.01	5.93
2120	0.83	2.29	6.91

Figure 1- 2-5 shows the land elevations that fall within the three sea level changes assumptions for coastal BFE. Each color indicates the additional area inundated from Hood Canal for each successively higher SLC assumption. The elevations shown in the figure are based on 2011 Lidar from the Puget Sound Lidar Consortium (PSLC 2011) and indicate land elevation only. Figure 1- 2-5 is not an inundation map. It does not show the influence of riverine inundation or the effects of roadways or flow control structures. USACE hydraulic analysis has not been carried out for this site and the riverine BFE has not been established for the three rate of rise assumptions. Most of the land in the Duckabush Estuary lies below the coastal BFE elevation, including some of the residences upstream of the site. Under conditions of sea level changes,

the inundation at the site will become deeper and the coastal flooding will affect more of the river valley upstream of the estuary including more of the residences. This flooding will occur regardless of whether the project is constructed or not.

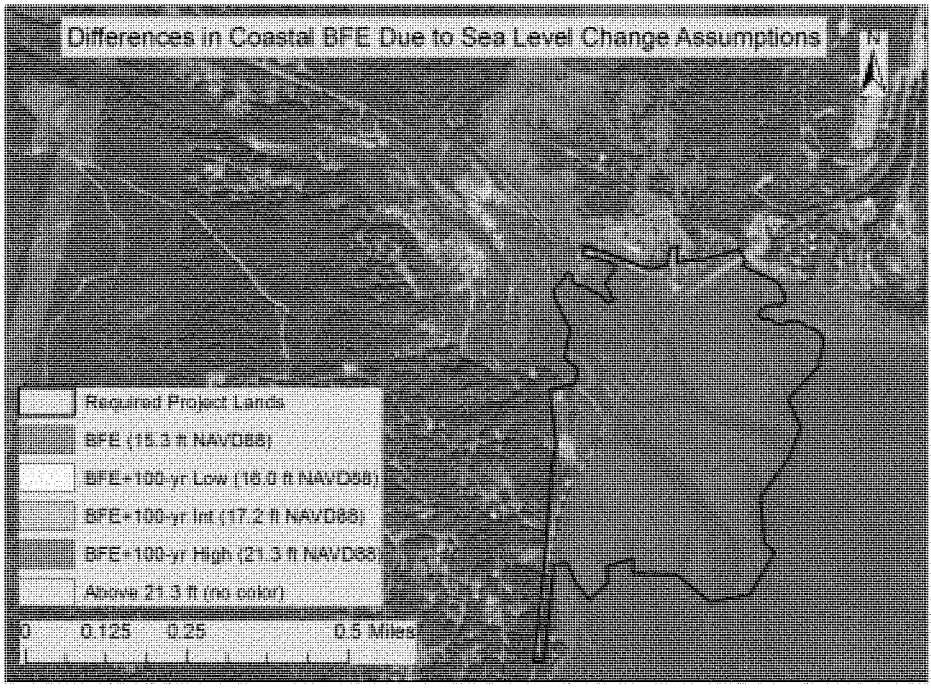


Figure 1- 2-5. Land at or below coastal BFE elevation for present day and projected 100 year low, intermediate and high rates of sea level change.

Figure 1- 2-6. Land at or below MHHW for present day and shows the land elevations that fall within the three sea level changes assumptions for Mean Higher High Water (MHHW). Each color indicates the additional area inundated from Hood Canal for each successively higher SLC assumption. Figure 1- 2-6 is not an inundation map, since USACE hydraulic analysis has not been carried out for this site. The elevations shown in the figure are based on 2011 Lidar from the Puget Sound Lidar Consortium (PSLC 2011) and indicate land elevation only – not the effects of roadways or flow control structures. The present day MHHW elevation covers some areas upstream of the Highway 101 roadway embankment. For successively higher rates of sea level change, more of the river valley is affected by SLC until, for the 100-year high rate of change assumption, some of the residences in the upper part of the estuary will lie below the MHHW elevation. This flooding will occur regardless of whether the project is constructed or not.

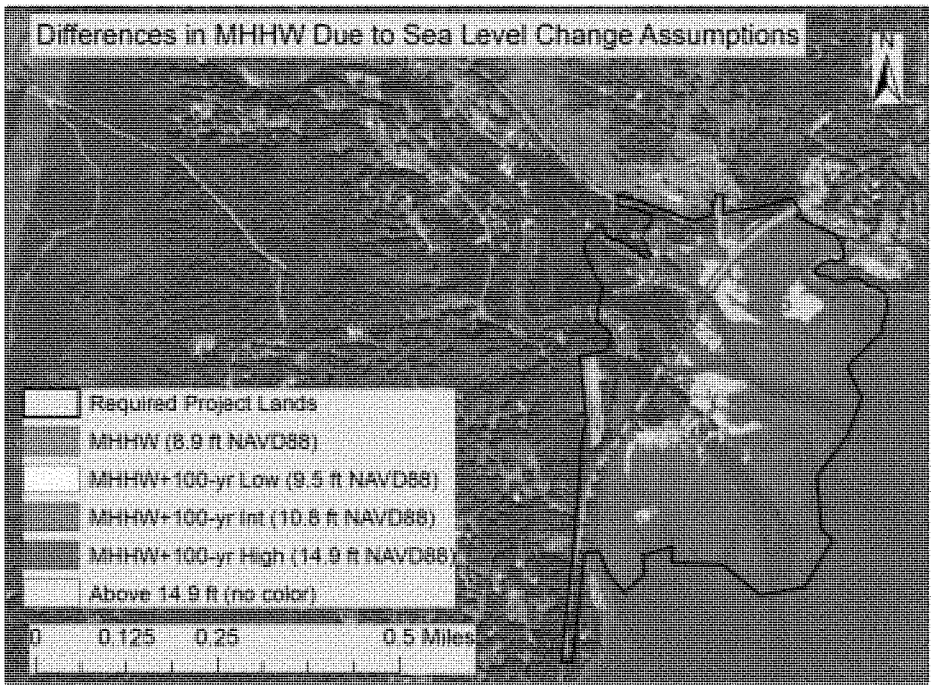


Figure 1- 2-6. Land at or below MHHW for present day and projected 100 year low, intermediate and high rates of sea level change

Figure 1- 2-7 shows the effects of potential SLC on the bridge at the Duckabush River Estuary. The design elevation chosen for the bridge is the 100 year intermediate level of change (roughly equivalent to the 50-year high level of change). While the PSNERP project planning timeline is 50 years, bridges are typically in place for much longer than 50 years. WSDOT bridges have a design life of 75 years and a service life which can extend well beyond that. The 100-year intermediate level of SLC was chosen as a scenario because the bridge is anticipated to be in place at least that long and likely longer. This design elevation was chosen using the following rationale:

- The bridge will still be usable for the 100 year high scenario. For the 100-year high scenario at Duckabush Bridge, the SLC is about 6 feet – if the bridge is designed for the 100 year intermediate of about 2 ft and the 100 year high SLC occurs, then the additional 4 feet of rise will eliminate the 3 foot debris clearance and impact the lower 1 foot of the bridge superstructure. The bridge will be designed to withstand this level of inundation on the bridge girders as well as possible debris impacts. A 100-yr high SLC scenario would mean higher OMRR&R costs for the bridge but not risk the integrity of the bridge or limit access.
- Highway 101 is the only North-South continuous roadway on the east side of the Olympic Peninsula. For a distance of 60 miles there are numerous low-lying waterway crossings. Most of these lie to the South of the Duckabush River. There is a single river crossing to the North at the Dosewallips River. For the 100 year intermediate scenario, the Duckabush Bridge may remain connected for emergency access to and from the North. For the 100 year high scenario, the Duckabush Bridge would not have connection to emergency services either northward or southward even if the bridge itself was unaffected.

- For the 100-year intermediate scenario, the road to the north may be passable since the Dosewallips River Bridge may only be partially inundated. Fewer locations on the road to the south are inundated compared to the 100-year high scenario.
- For the 100-year high scenario, much of the current road southward will not be passable in the BFE event as there are over ten inlet crossings that would lie below the BFE. The road to the North will be inundated at the Dosewallips River crossing preventing access to high ground inland.

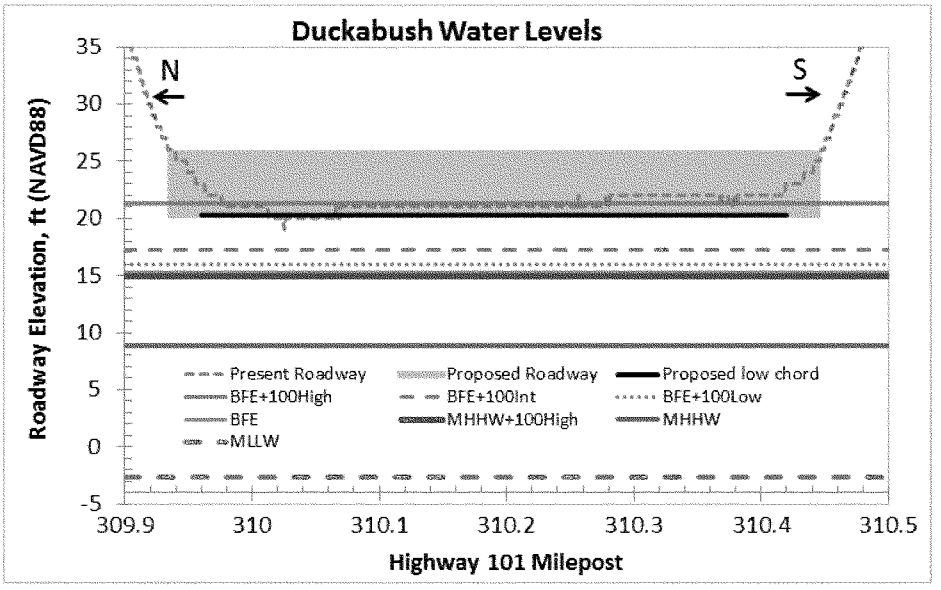


Figure 1- 2-7. Effects of potential sea level change on the base flood elevation at the Duckabush Estuary.

Change in Inland Hydrology due to Climate Change

ECB No. 2014-10 (USACE 2014) provides initial guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate change adaptation policy. There is a strong consensus among recent studies that future storm events in the Pacific Northwest region will be more intense and more frequent compared to the recent past (USACE 2015). The overall projected trends for the Pacific Northwest are summarized in the FR/EIS section 3.6.5.1.

Halofsky et al (2011) and Mauger et al (2015) present findings based on Global Climate Models (GCMs) for the Olympic National Forest and Puget Sound respectively. The modeling is based on greenhouse gas emissions scenarios proposed by the International Panel on Climate Change (IPCC) and range from an extremely low scenario involving aggressive emissions reductions to a high "business as usual" scenario with substantial continued growth in greenhouse gases.

The Duckabush watershed is a "two peak" water shed with a high peak flows from winter storms and a secondary snowmelt runoff peak. Reductions in snowpack and shifts in timing of snowmelt are expected with increasing temperatures in the 21st century. Halofsky et al report that April 1 snow water equivalent (a measure of water in snowpack) is projected to decrease by an average of 27 to 29 % across Washington State by the 2020s, 37 to 44 % by the 2040s, and 53 to 65 % by 2080. In the eastern Olympics they project an 8% increase in 5% AEP winter high flows and a 9% decrease 5% annual chance of occurrence summer low flows.

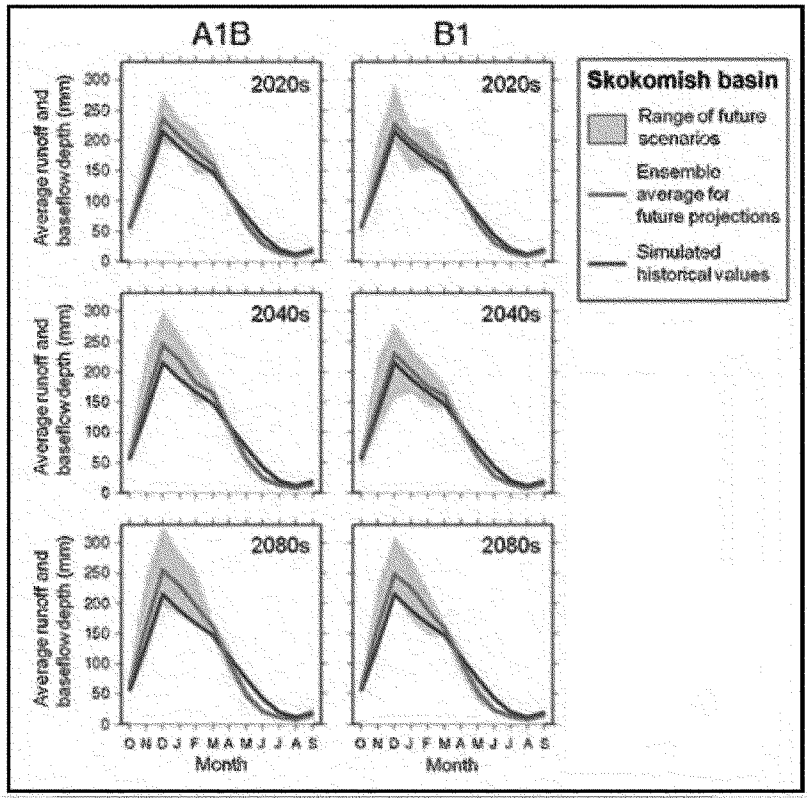


Figure 1- 2-8. Future projections for runoff for Skokomish basin using 10 global climate models (Source: Halofsky et al 2011).

Figure 1- 2-8 shows the simulated combined monthly average total runoff and baseflow over the entire Skokomish basin expressed as an average depth (millimeters). This variable is a primary component of the simulated water balance, and is one of the primary determinants of streamflow. The blue line shows the simulated historical values. Light red bands show the range of all future scenarios from 10 global climate models for the A1B (left column) and B1 (right column) emissions scenarios, and the red lines show the ensemble average for the future projections.

The current set of projections for the Eastern Olympic Mountains, reported in Mauger (2105) which stem from the most recent 2013 IPCC report and the results of 10 GCMs, predict a 20 to 60% increase in total winter runoff (December - February) by 2080, an increase in 24 hour runoff of 10 to 25% by 2080 and a decrease of 8 to 12% in summer precipitation. The results are less clear for peak flow values since less than 80% of the models had agreement on magnitude of change for the Eastern Olympic region.

1-2.1.10 Water quality conditions

Water quality information has not been reviewed in detail for this site. The restoration is not anticipated to generate any long-term effects on surface water quality. Anticipated water quality effects are as follows:

- Construction-related turbidity and suspension of sediments may occur due to removal of bank erosion protection and excavation of tidal channels. Sediment control will have to be carefully considered in the construction planning.
- Temporary increases in sedimentation may occur downstream of the site because of the release of sediment during the formation of any new distributary channels. These effects, together with other sedimentation issues, will be evaluated during PED.
- Levee lowering and channel construction may iucrease salinity within the site due to the increased tidal prism. Since the goal is to restore historic conditions, restoration of historic salinity patterns is presumed to be a desirable outcome. If needed, water quality sampling and analysis of water quality effects can take place during PED.

1-2.1.11 Groundwater conditions

No groundwater information has been reviewed for this site. The excavation of distributary channels will allow an increased tidal prism within the site which may be accompanied by saltwater intrusion. Since the goal is to restore historical conditions, restoration of historical salinity patterns is presumed to be a desirable outcome.

1-2.1.12 Preliminary project regulation plan

Not Applicable.

1-2.1.13 Preliminary real estate taking line elevations

The current real estate limits are delineated by the construction area, staging areas, and access roads and include the entire potential area of hydraulic effects. Real estate assumptions, valuations, and plauning documents have been appropriately scaled for the current level of design. As additional surveys, modeling, and design are completed during the PED phase, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Feasibility Report and Environmental Impact Statement (FR/EIS), Appendix C, *Real Estate Plan*.

1-2.1.14 Criteria for facility/utility relocations

Local utilities along Highway 101 will be relocated to follow the new bridge alignment. . For further details on the utility relocations see Section 1-6.3.

1-2.1.15 Criteria for identification of flowage easements required for project function

No flowage easements are anticipated for this site. This will be reviewed and confirmed during PED.

1-2.1.16 Criteria in support of project OMRR&R requirements

While channels are expected to evolve naturally once the stressors are removed, the larger channels and levee breaches have the potential to cause local aggradation, scour and transient sediment loading in and around the project and should be designed close to equilibrium conditions to avoid high initial maintenance costs. High initial sedimentation changes could cause a disruption to wildlife, fisheries and eelgrass downstream as well as impact the usual and accustomed fishing areas of local tribes. Rapid scour and aggradation of a channel as it adjusts to stressor removal could also require more maintenance and result in the loss of plantings. Operations, maiutenance, repair, replacement and rehabilitation needs associated with the hydraulic functiou of the site are as follows:

- This restoration concept relies on the natural evolution of the floodplain and channels and initial channel shape close to the equilibrium condition, therefore no hydraulic performance maintenance is anticipated. If site specific objectives aren't being met with the process based restoration features, there may be some adaptive managemeut required. Adaptive management costs are separate from OMRR&R.
- The roadways, bridges and culverts will require periodic maintenance. OMRR&R tasks are described in Section 1-15.

1-2.1.17 Environmental engineering considerations

In the context of hydrology and hydraulics, environmental engineering is taken to mean water supply and sanitation. Any existing water supply or sanitation systems within site boundaries will be decommissioned.

1-2.2 Residual Flooding Consequences – With Project Flooding

This section discusses the predicted hydraulic conditions after construction of the proposed restoration.

1-2.2.1 Warning time of impending inundation

There will be no residences or infrastructure within the site, except for the Highway 101 roadway and bridge. Aside from regional warnings for possible flooding, no warning system is planned.

1-2.2.2 Rate of rise, duration, depth, and velocity of inundation

No analysis of rate of rise and flow duration is planned for flood flows. The depths and velocities in the new tidal channels due to the combined effects of river flow and tidal prism will be evaluated during PED. This evaluation is required to confirm final channel dimensions and alignments.

1-2.2.3 Historic, 1% and 0.2% exceedance (100-year and 500-year) flood extents

The project is not expected to affect the 1% and 0.2% AEP flood extents.

1-2.2.4 Access and egress problems created by flooding

Highway 101 and Duckabush Road cross the site. The bridge and approaches are above the 1% AEP (100-year) flood elevation and are designed with 3 feet of debris clearance as well as an allowance for 100 year intermediate level of Sea Level Change (50-year high level). There will be no loss of access or egress during flood events due to the project. Area flooding may limit access to the bridge during floods due to local flooding upstream and outside the project area.

1-2.2.5 Potential for loss of life as a result of 1-2.2.1 through 1-2.2.3

The potential for loss of life as a result of the restoration is low. Areas within the site will be inundated by high tides. The entire site lies within the 100-year floodplain and is not likely to be occupied by people during floods.

1-2.2.6 Identification of any potential loss of public services

No public services are identified within the site. The fire station adjacent to the site should not be affected by the project. This will be confirmed during PED.

1-2.2.7 Potential physical damages

Potential physical damages that can occur during flooding will be addressed by the hydraulic analyses conducted during PED. This will include an evaluation of erosion and sedimentation as well as scour analysis of the bridge piers.

1-2.3 Project Induced Flooding – Change from Pre-Project Conditions

This section describes the effects of the site on flood elevations, flood patterns, and flood frequency.

1-2.3.1 Information categories required by 1-2.2

The project is not anticipated to cause any induced flooding.

1-2.3.2 Anticipated frequency of induced flooding

The project is not anticipated to cause any induced flooding.

1-2.4 Inundation Risk 0.2% Exceedance (500-year Return Interval) Flood

The site is dominated by the coastal base flood elevation which will not be affected by the project. Inundation risk for the 0.2% AEP event will remain the same.

1-2.5 Hydraulic Studies

This section discusses the hydraulic studies, construction considerations, and instrumentation and monitoring needs for the site. Hydraulic modeling during PED is being used both to fine tune the design of the bridge structure (piers and abutments) and to insure that channels are designed to achieve and to continue to achieve the desired ecosystem benefits with minimal maintenance. The anticipated hydraulic studies at this site are summarized in Section 1-21.

1-2.5.1 Hydraulic roughness determinations

If a hydraulic roughness determination is required to complete hydraulic analyses, then roughnesses will be determined using a combination of aerial photographs and field surveys during PED. Roughnesses will be calibrated using high water marks if available.

1-2.5.2 Water surface profiles

Water surface elevations as reported in the FEMA Flood Insurance Study (1982) require updating with recent hydrology, tidal information and coastal modeling. In order to predict the with-project water surface profiles, a 2-D coastal hydrodynamic model will be implemented which reflects the proposed geometry within the site and predicts an accurate Base Flood Elevation. This elevation is needed for design of the bridge and roadway, for detailed design of channels and to confirm the extent of ecological benefits. The model will include local inflows from surface water. In addition, an updated model of the flow in the Duckabush River is also recommended to evaluate the water surfaces within and upstream of the project boundaries and the effects of increasing the conveyance in the estuary. This modeling will be addressed during PED.

1-2.5.3 Stage-discharge relationships

Stage discharge relationships as reported in the FEMA Flood Insurance Study (1982) require updating with recent hydrology, tidal information and coastal modeling. In addition, an updated model of the flow in the Duckabush River is recommended to evaluate the frequency of occurrence of different stages within and upstream of the project boundaries. This information is needed to compete detailed design and to evaluate ecological benefits. This modeling will be addressed during PED.

1-2.5.4 Head loss

Other than the head losses that will be incorporated into the revised hydraulic model, no additional head loss studies are planned.

1-2.5.5 Flow and velocity

Flow and velocity information from the revised hydraulic analysis will be used to assess the possibility for sediment transport, scour, and bank erosion in the site area.

1-2.5.6 Structural sizing needed to meet design capacity including slope protection

No slope protection is planned for the site. Pier depths for the bridge will be designed to extend below scour depth or to terminate at bedrock. It is possible that some armoring will be needed for the bridge abutments or for the roadway along the shoreline. This has been incorporated into the cost risk register.

1-2.5.7 Water control facilities

Water control facilities at this site are limited to drainage culverts. Although they are included in the cost estimate, specific designs have not been developed for these features. These features will be designed during PED.

1-2.5.8 Energy dissipating facilities

No energy dissipation facilities are proposed. (Not applicable.)

1-2.5.9 Erosion control requirements

Construction

The currently planned earthwork for this site does not require dredging or water-based equipment. Overwater work will be completed with excavators from channel banks or access pads. Since the restoration includes earthmoving in and around water channels, appropriate in-water sediment control measures will need to be used during construction. Any in-water or overwater construction should follow accepted best management practices for erosion control. Planning during PED should evaluate the best and most cost-effective methods for excavation of the channels and for bridge pier installation. These may include excavation at extreme low tides, installing silt curtains, or possibly using a containment structure for work in the dry.

With Project

No erosion control is anticipated outside of the construction boundaries since the goal is to reestablish natural erosion and sedimentation processes. Roadway embankments and any existing beach face protection should be monitored for signs of scour at an interval to be determined during PED. The shoreline area planned for restoration should be monitored as well.

1-2.5.10 Existing and post-project sedimentation

The blockage of the Duckabush Estuary with the existing causeway limits the distribution of sediments across the estuary. Geomorphic evidence of abandoned channels, mostly to the north of the current channel shows that the entire delta was part of the active channel migration zone (USBR 2004). Review of Lidar does not seem to indicate that much sediment is impounded upstream of the current roadway embankment aside from in the aggraded blocked distributary channels, implying that most of the sediment is carried out of the estuary in the single thread channel and distributed offshore.

After restoration, distributary channels in the estuary may shift or avulse as part of natural sedimentation patterns. More sediments may be retained in the intertidal zone. The amount and potential areas of flow changes and sedimentation will be addressed during PED.

1-2.5.11 Water control and order of work during construction

Construction should be sequenced so as to minimize traffic interruptions and to maximize excavation under dry conditions. For further considerations refer to Section 1-2.5.9.

1-2.5.12 Criteria for facility/utility relocations

For details on the utility relocations see Section 1-6.3.

1-2.5.13 Other facilities to meet project goals

Stormwater detention is discussed in Section 1-6. No other facilities are planned in order to meet project goals.

1-2.5.14 Instrumentation and monitoring

A combination of field surveys and aerial photographs will be used to document biological and physical changes to the landscape. Monitoring data can be used to refine adaptive management and corrective measures, as needed. Some of the key monitoring needs and opportunities are summarized in the FR/EIS in Section 6.6.

1-2.6 Coastal Studies

Coastal base flood elevations were calculated by FEMA as a part of the Jefferson County Flood Insurance Study. The base flood elevations are calculated by combining the effects astronomical tide (caused by gravitational effects of sun and moon), storm surge (rise in water levels as a result of wind stress and low atmospheric pressure), waves breaking onto the shoreline, produce an additional water level rise at the beach (wave setup), and waves running up the beach (wave runup). The 1% annual exceedance coastal base flood elevation is shown on Figure 1-2-4.

It is assumed that the Duckabush Estuary is only subjected to wind waves caused by local winds. Measurements at the nearby Bremerton airport (Figure 1-2-9) show that the maximum wind speeds come from the southerly direction and rarely exceed 30 miles per hour. The orientation of Hood Canal results in a very narrow band of fetch in the southwesterly direction of up to 20 miles, which could result in wave heights up to 5.0 feet with a period of 5 seconds. The impact of wind waves is generally limited to the outer portion of the estuary; however, this area should be designed to withstand this type of wind wave action. These issues will be addressed during PED. The influence of wind wave activity, storm surge and wave setup will be evaluated during PED.

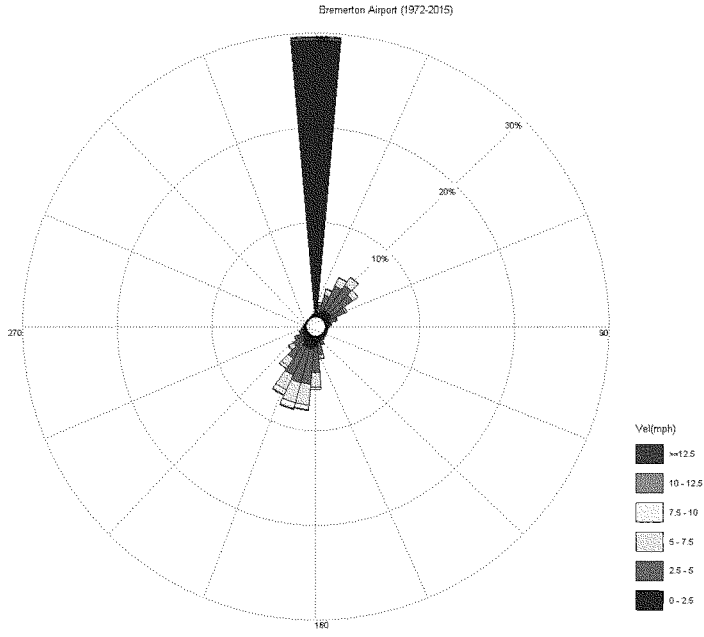


Figure 1-2-9. Wind Rose for Bremerton Airport.

Project plans formulated during the conceptual design phase for the Duckabush Estuary are based on a Mean Higher High Water tidal datum of 8.87 feet (NAVD88). This datum is from the tide gage at Seabeck (NOAA Gage 9445296). Major tidal datums are summarized in Table 1-2-4. The final design tidal datums will be reviewed and established during PED.

Table 1-2-4. Major tidal datums for The Duckabush site, Seabeck (Station 9445296)

Datum Description	Water Level (ft, NAVD88)
FEMA BFE (Coastal)	15.3
Mean Higher-High Water (MHHW)	8.87
Mean High Water (MHW)	7.92
Mean Tide level (MTL)	4.14
Mean Sea Level (MSL)	4.13
National Geodetic Vertical Datum of 1929 (NGVD29)	3.57
Mean Diurnal Tide Level (DTL)	3.12
Mean Low Water (MLW)	0.37
North American Vertical Datum of 1988 (NAVD88)	0
Mean Lower Low Water (MLLW)	-2.62

A summary table for the anticipated coastal studies at this site is presented in Section 1-21.

1-2.6.1 Design of coastal shore protection projects (ER 1110-2-1407)

This site does not include coastal shore protection. (Not applicable.)

1-2.6.2 Effects on adjacent shores

Downstream of the site, the shoreline transitions from a river delta to a bluffed-backed beach. The primary risk is an increase in sediment loading which could affect downstream intertidal and subtidal habitats in the river delta portion. At the bluff-backed beach, the primary forcing processes are coastal wind waves and longshore sediment transport which are expected to be minimally if at all affected by the restoration. The effects on downstream and intertidal habitat should be evaluated during PED, using results from similar inlets in Puget Sound.

1-2.7 Navigation Projects

There are no Federal navigation projects in the vicinity of the site. The Duckabush Estuary lies within a Regulated Navigation Area (RNA) subject to regulation 165.1328. This regulation applies to waters in the Hood Canal whenever any U.S. Navy submarine is operating in the Hood Canal and is being escorted by the Coast Guard. All persons and vessels located within the RNA shall follow all lawful orders and/or directions given to them by Coast Guard security escort personnel. Work at the site is not expected to affect operations in the RNA or other navigation in this area. The Bangor Submarine facility is located across Hood Canal over 8 miles away from the site and will not be affected by the project.

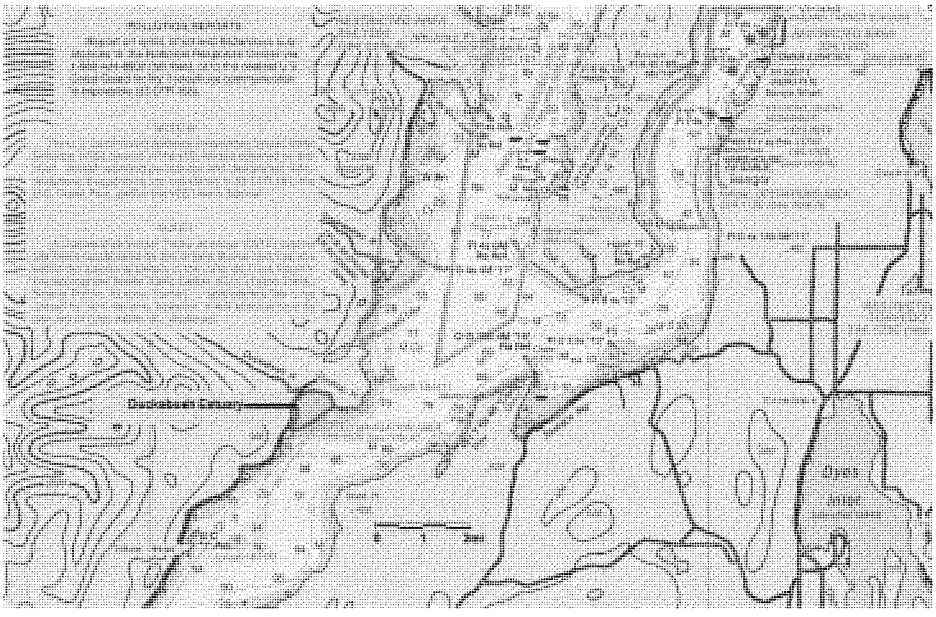


Figure 1- 2-10. Navigation chart for the vicinity of the Duckabush River Estuary (Source: NOAA RNC Online).

1-3 SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS

This section describes surveying, mapping, and other geospatial data information to support preparation of the FR/EIS and the *Real Estate Plan* (Appendix C of FR/EIS). A brief outline of additional surveying and mapping required for subsequent design, plans and specifications, construction, and operations is also included.

1-3.1 Surveying, Mapping, and Other Geospatial Data Information Used

Geospatial data for the Duckabush River Estuary site were obtained primarily from remote sensing applications. No site-specific topographic, bathymetric, property, or utility surveys were conducted during the conceptual design phase. LiDAR, aerial imagery, and other geospatial data were used to delineate topographic features, determine surface elevations, and to estimate areas, volumes, lengths, and other dimensions of key features using CAD and/or ArcGIS. High-resolution LiDAR was obtained from the Puget Sound LiDAR Consortium (2005 LiDAR; 3m grid; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://pugetsoundlidar.ess.washington.edu/lidardata/index.html). The Puget Sound Digital Elevation Model was used for combined bathymetry and topography of the Puget Sound lowland (Finlayson D.P., 2005; University of Washington; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://www.ocean.washington.edu/data/pugetsound). Recent aerial photography (Aerials Express, 5/15/2009, 0.3m resolution, 2.45 m accuracy) was evaluated to determine recent site conditions. The conversion from Mean Lower Low Water (MLLW) to North American Vertical Datum (NAVD88) and to the NGVD29 datum was derived from the Seabeck tide gage (Station #9445296).

Information on land ownership was derived from the Washington Public Lands Database. Additional parcel data, including parcel boundaries, were obtained from the Jefferson County assessors' office (2015). Information on utilities, existing roadway geometry, and other site features was generally scaled off of aerial photographs because as-built drawings were not available. A site reconnaissance was performed in September 2010 in a prior study phase.

Designers consulted the Nearshore Geodatabase for additional site context. The Nearshore Geodatabase is available from the Washington State Geospatial Data Archive at: http://wagda.lib.washington.edu/data/geography/wa_state/#PSNERP. Metadata are provided in the *Geospatial Methodology Used in the PSNERP Comprehensive Change Analysis of Puget Sound* (Anchor QEA et al., 2009) (see Annex B). The geodatabase includes numerous datasets listed below:

- Shoreline
- Bathymetry
- Digital Elevation Model (DEM)
- LiDAR (terrestrial)
- Oblique aerial imagery (from the Washington Coastal Atlas)
- Hydrographic sheets
- Geology
- Slope stability
- Drift cells (net shore-drift)
- Streams
- Impervious surfaces
- Overwater structures
- Marinas
- Armoring
- Breakwaters/jetties
- Groins
- Levees
- Dams
- Nearshore fill
- Roads
- Railroads
- Land cover

Designers also consulted the University of Washington Puget Sound River History Project 19th Century Coast Survey Topographic Sheets (2009) for information on historical geomorphic conditions. Conceptual designs were intended to replicate historical conditions and remove stressors to nearshore processes to the extent practicable and feasible. As a result, these datasets informed the selection of restoration strategies and features. Designers created additional GIS data layers (point files, line files, and polygon files) to represent civil design features, such as areas of lowland excavation, to be depicted on the plan

view drawings. Designers also created simple line drawings in CAD to represent typical sections and estimate quantity take-offs. Limited surface modeling was used to aid new roadway alignments and earthwork quantity take-offs.

1-3.1.1 Additional survey and mapping required

Substantial additional information will be required in PED to refine the design assumptions, confirm real estate requirements, and develop plans and specifications. Additional survey, mapping, and other geospatial data needs include the following:

- Property/Utility Survey – More detailed information on property boundaries and utilities will be needed to finalize the design and support real estate negotiations. The survey would also be useful in providing more accurate preliminary designs and quantities for excavations, utilities, and removal of existing features.
- Topographic/Planimetric/Bathymetric Survey – The conceptual design was based on LiDAR and aerial photos, which have inherent inaccuracies. Site-specific topographic, planimetric and bathymetric survey data will be needed to refine design of key elements, confirm that target elevations are appropriate for the desired ecosystem components (low marsh, etc.), and develop detailed construction and demolition plans. Survey data could also be used as a baseline for pre- and post-construction modeling, including hydrodynamic modeling. A temporary tide gauge may be required in the early design stages to obtain site-specific tidal statistics.

1-3.1.2 Timeline for incorporation of new mapping or other geospatial data

Planning, design, and implementation are expected to take several years. The site-specific surveys identified above are standard components of the design process and should be completed in the early stages of PED to ensure that the design work proceeds efficiently. Incorporating these data into the design process is not expected to delay the restoration.

1-4 GEOTECHNICAL

This section describes the geologic setting of the site, previous and recommended studies, and proposed geotechnical explorations relevant to design features.

1-4.1 Geotechnical Information

1-4.1.1 Regional and Site Geology

Regional geologic mapping from the State department of Natural Resources 2012, Geologic Map of the Brinnon 7.5-minute Quadrangle, Jefferson and Kitsap Counties, Washington, indicates site specific geologic features include sand, mud, pebbles, cobbles, and organic salt marsh deposits. This is part of the Marine deltaic alluvium (Qam). Bridge abutments are likely to be located on this deltaic alluvium, which has the potential for liquefaction. A section of the geologic map is shown below in Figure 1-4-1 and Figure 1-4-2.

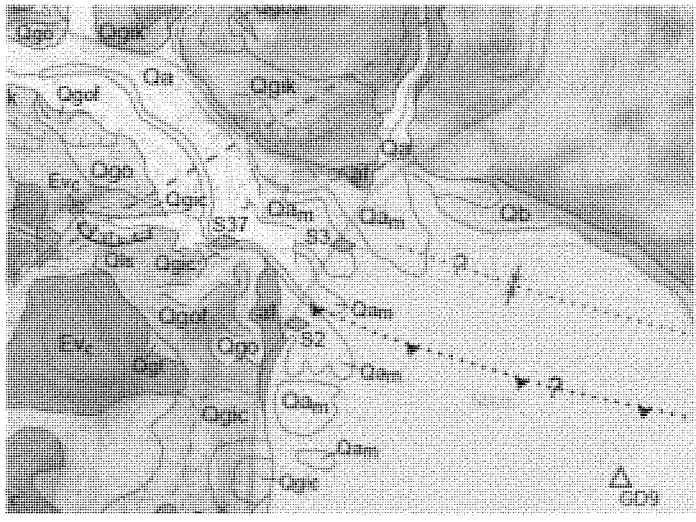


Figure 1-4-1. Geologic Map of Duckabush River Estuary.

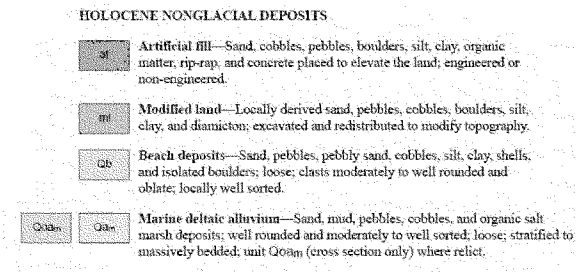


Figure 1-4-2. Soil type legend.

Near surface soils mapped in the project area by the United States Department of Agriculture (USDA) in the Soil Survey of Jefferson and Kitsap Counties, Washington is characterized by these soil types detailed in the figure above: Artificial Fill, Modified Land, and Marine Deltaic Alluvium.

According to the Washington Department of Ecology website there are three residential wells installed within 1300 feet of the existing bridges. One well is 350 feet northeast of the existing bridges, one well is 900 feet northeast, and one well is 1300 feet northeast. The three wells vary from 39-232 feet in depth and were drilled in 1994, 1999, and 1999. Typical profile has topsoil from 0-2 feet, sand to sandy gravel with clay from 2-20 feet, and clay with varying amounts of gravels and cobbles from 20 feet to bottom of hole, with basalt bedrock being encountered in one hole at 230 feet.

1-4.1.2 Completed explorations

At this time no subsurface explorations have been completed for this project. All subsurface information is based on research of soil surveys, geologic mapping, and wells logs available from the Department of Ecology. See Section 1-4.3 for the proposed subsurface exploration plan.

1-4.1.3 Selection of preliminary design parameters

Based upon research of the soils and geology in the project vicinity it is anticipated that subsurface soils will consist mostly of clay with varying amounts of sands, gravels, and cobbles. Preliminary design parameters have been selected for various soil descriptions which are likely to be observed at the proposed bridge foundation locations. Table 1-4-1. Preliminary design parameters.below provides a range of preliminary design values for the anticipated soils in the foundation.

Table 1-4-1. Preliminary design parameters.

Soil Description	Depth Range	Unit Weight, γ (pcf)	Friction angle, ϕ'	Undrained Shear Strength, S (ksf)
Clay to sandy clay with gravel and cobbles	0' – 200'+	90-115	-	2.0

Groundwater table was assumed at the ground surface. Bedrock is not likely to be encountered within upper 100 feet.

1-4.1.4 Geophysical investigations

No geophysical investigations have been conducted. It is recommended that there be shear wave velocity measurements, such as a seismic refraction survey to define the site class since the geologic map shows loose materials and organic salt marsh deposits. There is also the potential for liquefiable soils around the site.

1-4.1.5 Groundwater studies

No groundwater studies have been conducted for geotechnical design. Groundwater elevation is dependent on flows from the Duckabush River and the water surface elevation of Puget Sound. For geotechnical design purposes the groundwater will be assumed at the ground surface when considering the bridge foundations.

1-4.1.6 Recommended instrumentation

No instrumentation is recommended for this site.

1-4.1.7 Earthquake studies

In accordance with Table 20.3-1 of the 2010 ASCE 7, a Site Class C or D (NEHRP BC) is preliminarily recommended for this site when considering the average of the upper 100 feet. According to the 2008 United States Geological Survey (USGS) Earthquake Hazards website

https://geohazards.usgs.gov/deaggint/2008/, the Peak Ground Acceleration (PGA) predicted for the site is 0.428 g, and the maximum considered earthquake (MCE) ground motions for the site are S_s=0.946 g and S_1=0.335 g. In accordance with Tables 11.4-1 and 11.4-2, Site Coefficients F_a and F_v are 1.1 and 1.7, respectively for a Site Class D. Therefore the adjusted MCE ground motions are S_{MS}=1.041 g and S_{M1}=0.570 g. Therefore, design spectral acceleration parameters are S_{DS} = 0.694 g and S_{D1} = 0.380 g. The return interval for these ground motions is 5 percent probability of exceedance in 50 years (975 years). See Figure 1-4-3 below for earthquake deaggregation output.

Seismic design for deep foundations and bridge abutments shall be performed in accordance with the WSDOT requirements and the AASHTO LRFD Seismic Design Specifications. (AASTHO specifies 7% in 75 years, which is comparable to USGS 5% in 50 years.

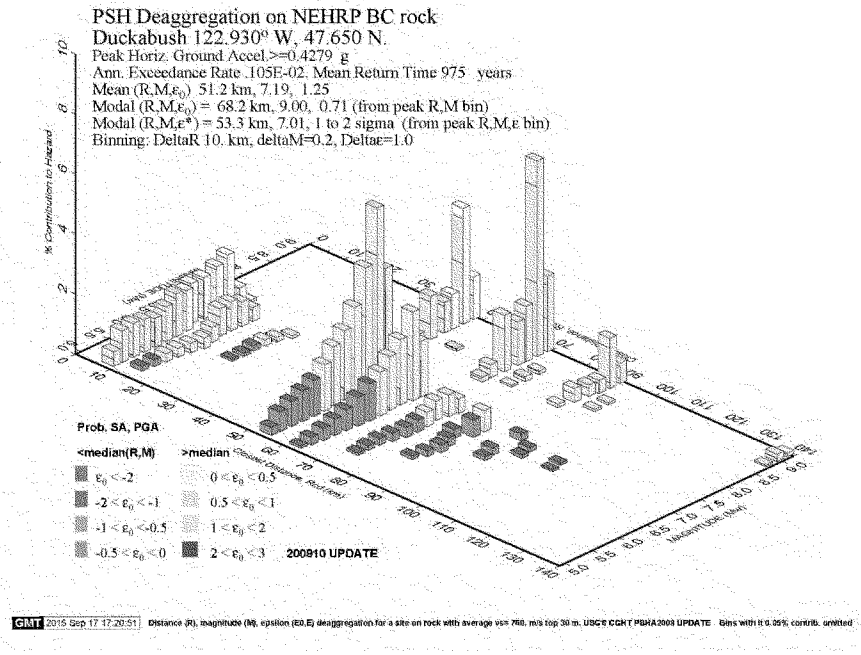


Figure 1-4-3. Deaggregation plot for Duckabush

1-4.1.8 Preliminary engineering analysis

There are two existing bridges on the site that will be replaced and removed. The existing bridges were built in the 1930's. The first is a concrete tied arch bridge with a span of 110 feet supported by concrete piers. The second bridge has 4 spans at 30 feet apart and is supported by concrete piles at the end of each span. At both bridges, the piles are at an embedment depth sufficient to develop the minimum HS-15 (the highway rating at the time) load capacity.

The proposed 2100-foot long multi-span concrete I-girder bridge that will replace these two bridges will be supported by deep foundations. The foundation design assumes two, 7-foot diameter drilled shafts at 15-foot spacing (inside edge to inside edge) with a 135-foot embedment depth at the end of each span.

Drilled shafts or driven piles are acceptable foundation alternatives for the proposed bridge. To minimize negative effects to protected species, pile driving is uot a preferred option due to the loudness and vibration of pile hammer impacts. In addition, if rock or till is encountered at a shallow depth under the

bridge abutments, drilled shafts socketed in rock will be the preferred alternative as driving piles at such subsurface conditions would be difficult. Shallow foundations are not a preferred option at this time due to potential seismic loading and scour.

A preliminary estimate of foundation capacity using the lower range of the parameters in Table 1-4-1 was used as a verification of the conceptual foundation design from the 10% design. See Table 1-4-2 for results of the estimate.

Table 1-4-2. Preliminary foundation axial capacity estimate.

Feature	Description	
Bridge	Total length (feet)	2,100
	# of spans x Approx. span length (feet)	18 x 120
	Approximate width (feet)	34
	Dead load x 1.25 [LRFD strength I] (kips) / pier[1]	1,525
	Live load x 1.75 [LRFD strength I] (kips) / pier[2]	395
Foundation	Type	Drilled shaft
	Diameter (inch)	84
	# piles / pier	2
	Depth (feet)[3]	135
Load	Estimated static loading demand (kips)	960
Capacity	Factored pile resistance (kips)	1,125
	Sufficient capacity	OK

[1] Dead load estimate is based on bridge dimensions in the 10% design report
[2] Live load estimate is based on HL-93 (HS-20 Truck + 0.64k/ft lane).
[3] A 20% contingency was added onto the depth calculated.

Each end of the bridge will require an earthen abutment to tie into. If there is liquefaction potential found in the site soils, the abutments will need to be supported by 4 or more shafts that extend down to a stable depth, preliminarily set at 135 feet below ground surface.The foundation capacity estimate is preliminary without any site specific subsurface information. Upon completion of subsurface explorations, foundations should be designed using encountered subsurface conditions. Downdrag on the drilled shafts shall also be analyzed. At this time the foundation design includes the use of drilled shafts at a depth of 135 feet. It should be noted that if liquefaction potential soils in the foundation are present, the depth of the drilled shafts may increase. Likewise, if bedrock or dense or hard soil is encountered the depth of the drilled shafts will significantly decrease. Seismic loading, liquefaction potential, and scour are not included in the current conceptual level design.

Slope stability analysis has not been evaluated at this time. Slope stability and settlement analysis for the entire length of the approach embankments shall be performed upon completion of the design and geometrical configuration of the bridge. Ground improvements may be required at the bridge abutments/roadway approaches if liquefiable soils are encountered.

1-4.1.9 Excavatability analysis

Excavation of the existing channel, bridge abutments and approach embankments will be required to meet the proposed ecosystem restoration. The amount of riprap to be used to protect the piers of the existing bridges is not known. It is estimated that approximately 500 CY of rock armor (12-24 inch riprap) has been placed to protect the piers and abutments from scour. No explorations or construction records were located for the new embankment site therefore the embankment material is unknown. Based on soil and geology maps in the area and historic project as-builts, as well as explorations from the Department of Ecology, it may be assumed at this time that the existing embankments consist of a combination of clay with gravel, sand, and cobbles throughout. Excavation of riprap and fill may be accomplished using an excavator.

The anticipated amount of rock could be small and rock excavating equipment may be necessary with the unlikely need for blasting. According to construction records for the existing bridges, bedrock was not encountered during construction and is not likely to be encountered during construction of the new bridge.

1-4.1.10 Anticipated construction techniques and limitations

The existing bridges can remain open to traffic during construction of the new bridge. Some rerouting and traffic control may be necessary when connecting the new roadway to the existing roadways.

Demolition of the existing bridge and embankments will likely require a crane and excavator. The existing bridge superstructure and piles will be removed by crane. The concrete piles will likely be demolished to the ground surface if deemed acceptable. Removal of timber piles is typically accomplished by cutting or breaking them at the ground line. In a sensitive marine environment, more careful excavation around each pile and cutting a certain distance, a foot or more below ground line, may be required. One of the existing bridges is considered a historical structure and may need to have preservation efforts in place before removal. The existing fill embankments and armoring will be removed by excavator.

Land-based drilling augers will be used to install the deep foundation at the bridge abutments and at each pier. At this time, work is anticipated to require land-based large augers, excavators, cranes, concrete trucks, and dump trucks.

The type of deep foundation will be confirmed during PED once subsurface explorations have been completed. At this time it is assumed drilled shafts will be used to support the proposed vehicle bridge. Due to the presence of soft and caving soils and anticipated high groundwater, either casing or wet method is recommended for construction of drilled shafts. Upon completion of the shaft excavation, the hole is cleaned and the reinforcing steel cage is placed to the bottom of the hole. The casing is then carefully extracted fully or partially leaving a top segment to facilitate column installation and concrete is cast. Once the shafts are installed, the columns are cast, pilecaps and bridge superstructure are constructed.

There are potentially several utilities at this site which will need to be relocated. Utility configuration and design will be determined through coordination with service providers.

See Civil Section 1-21 for additional construction notes.

1-4.1.11 Potential borrow sources and disposal sites

No borrow sites or disposal sites have been identified within the project extents. Approximately 21,300 CY of borrow will be required for the project. Borrow/fill for the roadway transitions will likely come from a local quarry. Over 41,900 CY of material will require disposal. Offsite disposal and borrow sites are available within a 60 mile distance from the site, either to the North at Port Angeles, WA, or to the South at Tumwater, WA. Borrow and disposal sites shall be confirm during PED. The uncertainties associated with confirming suitable borrow and disposal sites have been captured in the cost risk register.

1-4.1.12 Potential sources of concrete and materials

Preliminary investigations indicate that there are several options for receiving concrete materials. This is a major highway and delivery to the site will be relatively easy.

Suitability of concrete and materials will be evaluated at later stages of design or during construction.

1-4.1.13 Suitability of concrete and materials

Suitability of concrete and materials will be evaluated during PED.

1-4.2 Additional Studies and Analysis

Additional studies and analysis to be completed during preliminary engineering design (PED) or subsequent phases of design at a minimum include the following:

- Geotechnical Investigation: subsurface explorations, testing, and field reconnaissance
- Foundation Design: static and seismic analysis according to AASHTO LRFD
- Abutment Stability (include potential for liquefaction and ground improvement)
- Pavement Design: new roadways and approaches (include traffic analysis for ESALs)
- Scour Study: at roadway embankments, abutments, and bridge piers

1-4.3 Additional Explorations and Testing

The proposed subsurface exploration plan consists of drilling borings at the proposed bridge abutments, piers and approach embankments. In addition, test pits should be conducted along the roadway transitions for at grade construction and pavement design. For the roadways test pits shall be spaced approximately every 250-500 feet. Based on research of the site and preliminary foundation design the bridge borings should be a minimum of 135 feet below the ground surface and test pits a minimum of 10 feet. The preferred exploration method for the borings is mud rotary. Test pits shall be accomplished with a backhoe or small excavator.

Sampling in the soil borings shall be accomplished using standard penetration test (SPT) with samples taken typically every 2.5' for the top 10 feet and every 5' for the remained of the boring depth. Proposed soil lab testing shall comprise shear strength testing of undisturbed cohesive soil samples, moisture content, grain size analysis, and percent finer than #200 sieve. Atterberg limits and consolidation tests are recommended for cohesive soils, and unconfined compressive strength test for rock cores if they are encountered.

1-4.4 Laboratory-testing Program and Evaluations

No laboratory testing or evaluation of materials has been completed at this time. Testing to be completed during PED is outlined in Section 1-4.2.

1-5 ENVIRONMENTAL ENGINEERING

This section describes environmental engineering factors relevant to the proposed design features.

1-5.1 Use of Environmentally Renewable Materials

At this design stage, use of environmentally renewable materials is not planned. However, if renewable materials are available they could be incorporated into the design. Specific details will be developed during subsequent design stages.

1-5.2 Design of Positive Environmental Attributes into the Project

The Duckabush River Estuary site was selected to address River Delta restoration objectives to restore freshwater input and tidal processes where major river floodplains meet marine waters. The proposed action involves removing the substantial fill for Highway 101 and the two bridges from the intertidal zone to allow restoration of the natural processes of freshwater input, sediment accretion and erosion, and distributary channel formation. This action will restore habitat for threatened salmonid species, estuarine and saltwater marsh, and estuarine biodiversity.

1-5.3 Inclusion of Environmentally Beneficial Operations and Management for the Project

Design and construction will incorporate sustainable and ISO 14000 compliant practices. The U.S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOPs) are designed to provide direction on achieving better stewardship of air, water, and land resources while showing the connection

between managing those resources and protecting environmental health. The EOPs are to ensure that USACE actions consider the environment and are sustainable now and in the future.

1-5.4 Beneficial Uses of Spoil or Other Project Refuse during Construction and Operation

Beneficial uses of spoil or other refuse are possible. If spoils or other refuse materials are available for reuse, they could be incorporated into the design. Specific details will be developed during PED. The FR/EIS describes measures to minimize energy consumption for the purpose of reducing greenhouse gas emissions. These measures would also serve to minimize energy consumption.

1-5.5 Energy Savings Features of the Design

At this design stage, energy savings features have not been incorporated. In accordance with the EOPs, energy savings features will be a component of the design to the maximum extent practicable.

1-5.6 Maintenance of the Ecological Continuity in the Project with the Surrounding Area and Within the Region

The restoration will increase ecological continuity within the site and with the surrounding area. This is one of several sites designed to restore the productivity and increase interconnectivity of the Puget Sound ecosystem.

1-5.7 Consideration of Indirect Environmental Costs and Benefits

All direct, indirect and cumulative environmental costs and benefits were evaluated during the environmental impact assessment and alternatives analysis recorded in the Final FR/EIS

1-5.8 Integration of Environmental Sensitivity into All Aspects of the Project

Construction will be condncted to ensure no long term deleterious impacts to the ecosystem will occur. Best management practices will be incorporated into the contract documents. Most management practices will cover erosion and sediment control, stormwater management, spill response and hazardous material management, trash and debris management, air emissions from construction vehicles, and noise standards.

1-5.9 Use of Environmental Review Guide for Operations (ERGO) with Respect to Potential Future Environmental Problems

This is not a USACE operating facility. (Not applicable.)

1-5.10 Incorporation of Environmental Compliance Measures into the Project Design

All applicable laws and regulations will be followed during design and construction in accordance with the USACE contract documentation.

1-6 CIVIL DESIGN

This section discusses the key elements of the civil design including the selection of the site and evaluation of alternative layouts, alignments, and components.

1-6.1 Site Selection and Project Development

The Duckabush River opens to a moderately wide steep-walled valley within the action area. The river is contained within a single channel through the site before emptying into the marsh and submerged marsh outboard of the site. The historic northern arm of the river has been blocked, is aggraded, and is a dead-end channel in the middle portion of the site. Both channels are tidally influenced and pass under bridge crossings. Training berms are in place at the southern arm, just upstream of the Highway 101 crossing, to control lateral movement of the channel. The northern channel branches to form smaller dead-end channels upstream of Highway 101, and receives freshwater flow from a connection to the small tributary that crosses Shorewood Road.

Pierce Slough, located at the northwest corner of the site, is partially disconnected from tidal flows by the culverted Highway 101 crossing. A remnant tidal channel network exists outboard of the highway between the north and south channels. The northern tidal channel network appears to have aggraded over time, though it is partially present today.

The proposed action would restore the natural geomorphology to the Duckabush River delta wetlands by removing major roadway obstructions, excavating channels, and removing fill. The action would realign Highway 101 across the estuarine delta to restore tidal connection to the estuary. A surface street crossing (Shorewood Road) would be modified and adjacent fill at a distributary channel (Pierce Slough) would be removed. Multiple tidally influenced distributary river channels would be reestablished, and blind tidal chanuels would be excavated within the marsh areas.

Table 1- 6-1-summarizes the key design elements associated with the proposed restoration. Annex 1-1 contains exhibits that depict the proposed restoration design elements.

Table 1- 6-1. Key Design Elements

Item	Description of Item	Approximate Quantity
Roadway Removal	Remove 3,800 LF of Highway 101 embankment including removing several culverts, approximately 900 feet of Duckabush Road, and 150 feet of Shorewood Road and culvert. The current highway roadway extends down to about the MHHW line (MHHW is 11.5 feet above MLLW).	4,850 LF
New Roadway	Build 1,900 feet of new highway including 1 drainage culvert replacement, 800 feet of Duckabush Road, and 80 feet of new Shorewood Road. New highway roadway elevation will be at about 28.5 feet above MLLW. About 1000 feet of the revised highway embankment may extend below the MHHW. Duckabush road and Shorewood road will remain at their current elevations.	2,780 LF
Bridge Removal	Remove two existing Highway 101 bridges. Bridge decks at 22.5 feet above MLLW.	970 LF
New Highway 101 Bridge	Build one 2,100-foot bridge at 28.5 feet above MLLW (18 spans at ~E120 feet). In the next phase of design, the span length and number of piers in the bridge design will be refined to maximize environmental benefits by holding the total number of piers to the minimum required for structural safety, adherence to AASHTO specifications and optimization of costs. Build 60-foot bridge approach at Duckabush Road.	2,100 LF
New Shorewood Road Bridge	70-foot bridge at Shorewood Road. Shorewood Road elevation 13.8 feet above MLLW.	70 LF
Overhead Power	Relocate to new alignment	
Distributary Channels (large)	675 feet of north chanuel connection to the maiustem of the Duckabush River (12.5 to 2.5 feet above MLLW) and 480 feet of south channel connection to mainstem (12.5 to 6.5 feet above MLLW). Maximum channel depth: 9 to 10 feet	1,155 LF
Distributary Channels (small)	1,900 feet of Pierce Slough Reconstruction (12.5 to 6.5 feet above MLLW); 2,300 feet of other tidal channels 12-6 feet above MLLW). Maximum channel depth: 5.5 feet.	4,200 LF
Fill Removal	Remove training berms along river (0.7 acre) (0-18 feet above MLLW), road embankment and roads (3.3 acres), and developed areas (2.5 acres)(all > 11.5 feet above MLLW)	6.5 acres

1-6.1.1 Basis of Design

The Highway 101 roadway cuts across the intertidal river delta and estuary wetland complex, severely affecting water flow, sediment transport, and morphology. Removal of this stressor will restore and improve physical and ecologic processes. Reconnection of the north distributary channel would improve estuary processes by restoring delivery of fresh water and fluvial sediment. Bridging of existing surface streets (Duckabush River Road, Shorewood Road) would reconnect freshwater and tidal flows to remnant distributary, tidally influenced channels and tributary wetlands. Removal of training berms along the active river channel would reconnect the river to its intertidal floodplain and wetlands, restoring floodplain and estuary wetland processes, and increasing channel density.

Removing these multiple stressors would restore dynamics and promote greater diversity of delta wetland habitats. Together the Highway 101 bridges and roadway embankment occupy a span of over 1700 lineal feet across the mouth of the estuary. The bridge span of 2,100 feet is the result of feasibility level engineering of the conceptual design to meet the required ecosystem outputs. There are several reasons why this bridge length was chosen.

- The design of a bridge built to modern standards requires raising the low chord of the bridge about 5 feet to allow for the base flood, clearance for debris and an assumption of about 2 feet for an intermediate rate of sea level rise in the next 100 years (see Section 1-2.1.9). The conceptual design did not take into account the need to raise the bridge.
- Raising the bridge and roadway by 5 feet would require significant additional fill in the estuary for all but the estuary spanning bridge length. That is, benefits would actually be negative until the bridge reaches about 1700 feet.
- Since the Duckabush estuary is in a steep-walled valley, connecting the new bridge with the existing roadway within DOT guidelines for vertical and sag curves requires either large amounts of roadway fill or an extension of the bridge to 2100 feet. While it may be possible to use a somewhat shorter bridge length, it is not clear that there would be a significant cost savings so this optimization is deferred to PED.

During PED phase the PDT will examine trade-offs and value engineer the recommended alternative to minimize costs while optimizing desired benefits. This will be accomplished by detailed engineering once the site investigations and surveys recommended for PED have been completed and base flood elevation has been confirmed by modeling. The proposed action includes removal of approximately 3,800 LF of Highway 101 including two existing bridges. The highway will be replaced with an elevated structure, with new roadway approaches at either end of the bridge. Duckabush Road will be realigned both horizontally and vertically to connect to the new highway bridge. An interchange will be constructed at Duckabush Road to allow tidal exchange with the marsh to the northwest. The overhead power lines that currently run parallel to the existing roadway will be relocated to the new structure. New roadway embankments will be required at the north and south approaches to the new Highway 101 Bridge. A new bridge will be constructed at Shorewood Road and a culvert will be removed to make room for a restored (widened) distributary channel (Pierce Slough). Highway 101 modifications are based on WSDOT 2010, Design Manual M, Modified Design Level. Table 1- 6-2. Purpose and usage of transportation features.summarizes the rationale for modification of the roads and bridges at the Duckabush site.

Table 1- 6-2. Purpose and usage of transportation features.

Element	Element Purpose	Road/Bridge Use	Emergency use (Y/N)
• Remove 3800 ft of Highway 101 • Remove 2 Hwy 101 bridges • Build one 2100-foot bridge (18 spans at 120 feet) • Build 1900 feet of new roadway	Remove principal stressor of Duckabush Estuary Allow free estuary development and migration by use of piers and bridge location further upstream Minimize maintenance by use of piers	Interstate Highway [2200 vehicles per day (2014)] only means of travel N-S on Eastern side of Olympic Peninsula	Yes
• Remove 900 ft of Duckabush Road • Build 60-foot bridge approach and entrance/exit for Highway 101 • Build 800 feet of Duckabush Road	Allow activation/passage of Pierce Slough Allow connection from Duckabush Valley to Highway 101	Secondary road Only route of ingress-egress to/from Duckabush river valley, (Population ~ 350) Junction with Highway 101.	Yes
• Remove 150 of Shorewood Road • Build 70-foot bridge at Shorewood Road • Build 80 feet of Shorewood Road	Remove culvert, allow reactivation and passage of Pierce Slough	Secondary road Access road for Duckabush Fire station	Yes

Stormwater runoff from the project is required to meet Federal Energy Independence Security Act (EISA), State, Washington State Department of Ecology and local requirements. EISA requires sites in excess of 5000 square feet to retain the total volume of rainfall from the 95th percentile of the 24-hour storm on site. The alternative is to require the post development hydrology to not exceed the pre-development hydrology (prior to man) by using site specific stormwater BMP's such as infiltration, evapotranspiration and detention. WSDOE requires that the duration of the developed storm flow be less than 50% of the 2 year through the 50 year events. The WDOE water quality provisions require that treatment facilities be designed for the 24- hour storm with a 6-month return frequency or a simulated daily volume that accounts for 91% of the entire runoff volume over a multi-decade period of record.

For feasibility design, a provision for stormwater is included in the estimate. Once the site hydrology is confirmed in PED, stormwater detention will be designed where required. The risk of the assumption for stormwater treatment size has been captured in the Cost and Schedule Risk Analysis.

Distributary channels will be excavated at or near their historic configurations. Large and small distributary channels will be excavated to thalweg elevations of 2.6 feet and 6.6 feet MLLW (0 feet and 4 feet NAVD88), respectively, and top widths of 50 feet. These channels are sized based on historic data, primarily the drawings for the existing Highway 101 (Washington State 1933), and interpretation that the datum was close to MSL, which is about 6.8 feet MLLW (4.1 feet NAVD88). Historic maps, LiDAR, and aerial photographs were used to locate the excavations.

Two large distributary channels will be created, connecting to the existing Duckabush River mainstem on the north side, and ending at the remnant channel in the middle of the delta. Four small distributary channels would be excavated, and two existing channel connections expanded farther toward Hood Canal. One of the new small distributary channels would reestablish Pierce Slough at or near its historic alignment.

The road embankment will be excavated and removed to match the adjacent grade on the downstream side, which is at elevation 11.6 to 12.6 feet MLLW (9 to 10 feet NAVD88). Six areas of about 2 to 6 acres each will have channels excavated to establish natural intertidal marsh morphology (Exhibit A). The channel cross sections have been sized using the Applied Geomorphology Guidelines (Attachment B). The channels include-third-order cross sections, connected to the distributary channels.

The 1883 topographic sheet (T-sheet) shows two distributary channels at the outlet of the Duckabush River (Figure 1-6-1). The banks of the river transition from mixed forest and grassland upstream, to salt marsh and submerged marsh at the mouth of the estuary. Some settlement had occurred at the time of the survey, with an orchard visible on the north side of the northern channel and a crossing on the mainstem of the river upstream of the distributary channels. A developed tidal channel network was present in the outboard marsh between the two main channels and north of the northern channel. A single road is shown to access the settlement from the north at the northern edge of the marsh, cross a tidal slough (Pierce Slough), and then cross the mainstem of the river upriver from the more recent alignments (existing and previous crossings are farther east).

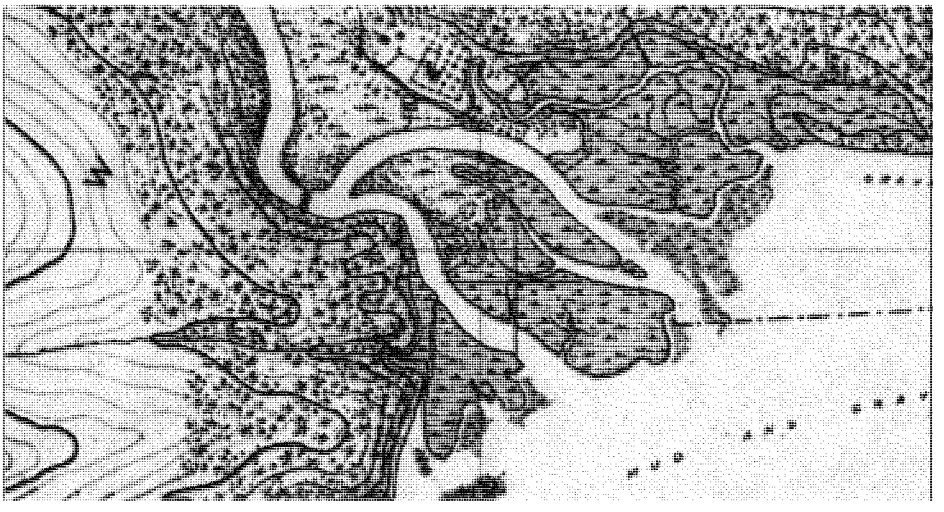


Figure 1-6-1. Historic Map (T-Sheet) and River History Project Data

1-6.1.2 Constructability

A 2,100 foot long x 30 foot wide x 4 feet high temporary construction platform adjacent to the bridge alignment, composed of granular fill over a geotextile fabric is planned. This assumes the existing ground is at elevation 8 feet NAVD88 and the platform top is at elevation 12 feet (MHHW is 8.9 feet). The embankment would not span any waterway so the estimate is conservative in length. This extra material will be used for access and for a 40 foot x 60 foot x 4 feet high work pad at the pier locations.

The 30 foot wide top width should provide enough room for a crane and room to work around. This would look similar to Section C on Exhibit B.

The construction and removal of the platform will cause temporary disturbance to fish and wildlife though increased noise and turbidity. These impacts will be minimized by work during designated in-water work windows when sensitive species are least likely to be present, implementing BMPs, and monitoring water quality during in-water work. The entire temporary platform would be removed aud the site restored on completion. This would include uncompacting 3 feet of soil that lies below the embankment, and supplementing as needed to raise the elevation to the adjacent ground on all sides. The stripped material will be stockpiled and blended with the final topsoil layer, utilizing the native seeds in the native material. Any vegetation that is disturbed would be replanted post construction.

No significant water diversions are anticipated with this work.

The distributary chaunel excavation cross sections have 2:1 slopes (Exhibit B). This is a steep slope, especially for the two large distributary channels that require excavation to approximately 10 feet below existing grade. It is assumed that a track-mounted crane with a clamshell (or dragline) bucket could accomplish the excavation in the wet, and that slopes would be stable during construction. Further consideration of constructability is recommended, including subsurface exploration of soil properties and a geotechnical report. Also, sloughing of the banks should be expected, and the limits of excavation should be evaluated to prevent impacts on adjacent areas. Excavation would be required at a few locations that are well within the delta and away from established access roads. Construction of these areas would need to occur before distributary channels are excavated through the delta cone deposits. While marine equipment could be used, the complexity of offloading the excavated sediment and taking it upland would add costs; therefore, the use of marine equipment is not considered practical. Access to construct the distributary channels would attempt to minimize disturbance of the area and the access routes would be restored on completion. The access routes will be evaluated during PED.

Construction sequencing should keep the fire station and Duckabush road open for 24/7 access. This sequencing will be further evaluated dnring PED. During PED phase the PDT will examine trade-offs and engineer the recommended alternative to minimize costs while optimizing desired benefits. This will be accomplished once the site investigations and surveys recommended for PED have been completed.

1-6.2 Real Estate

Real estate assumptions, valuations, and planning documents have been appropriately scaled for the current level of design. As additional surveys, modeling, and design are completed during PED, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Final FR/EIS, Appendix C, *Real Estate Plan*.

1-6.3 Relocations

The overhead power, telephone, and telecommunications lines (approximately 3,200 feet) that currently pass along the existing causeway would be relocated to the new bridge and roadway alignment. Additionally, an overhead electric/phone line approximately 550 feet long runs from Highway 101 near the northern channel to the fire station.

Table 1-6-1. Facility / Utility Relocations

Facility / Utility	Activity	Subsequent Design
Overhead power distribution and transmission lines	Relocate from existing causeway to new bridge and roadway alignment	Coordinate with utility owner on phasing of work.
Telephone and telecommunications lines	Determine locations and relocate if applicable	Coordinate with utility owner on phasing of work.
Gas lines	Not Applicable	Not Applicable
Sanitary sewer septic systems	Determine locations and assess removal or relocation if applicable	Need for decommissioning analyzed during PED.
Water wells	Determine locations and assess protection or removal if applicable.	Need for decommissioning analyzed during PED.

1-7 STRUCTURAL REQUIREMENTS

This section discusses the structural elements of the proposed restoration including preliminary design requirements and criteria for bridges or roads, a description of major structures and construction considerations, and recommended analyses.

1-7.1 Functional Design Requirements and Technical Design Criteria

Functional Requirements: The new Highway 101 Bridge is designed to support two lanes of traffic in addition to shoulder spaces. The design accommodates horizontal and vertical hydraulic clearances needed to achieve the restoration goals at this site. The design is intended to be low maintenance and should meet the AASHTO Bridge design specifications as well as the WSDOT Bridge Design Manual requirements. The bridge is designed for a minimum service life of 75 years. In addition to the main stretch of the Highway 101 Bridge, a short bridge that connects the Duckabush Road to the main alignment is needed. The Duckabush Approach Ramp bridge structure will be constructed of the same design as the main alignment and it will be physically isolated from the main alignment by a separation joint.

Key design elements are summarized in Table 1-7-1 below.

Table 1-7-1. Summary of Bridge Information

Bridge Location	Description
New Highway 101 Bridge alignment	• New 2,100-foot long curved bridge, 32-feet wide; • (18) spans no greater than 120-feet each span; • (5) lines of standard WASDOT WF50G girders at each span; • (17) cast-in-place concrete pile caps, 5-foot deep by 6-foot wide by 32 feet long; • (2) concrete columns, 4-ft in diameter, at each pilecap; • (1) 7-foot drilled in concrete shaft at each column; • (1) Abntment at each end with four drilled-in shafts, 7-foot diameter. (see Geotechnical for shaft depths)
Approach to the new bridge alignment at Duckabush Road	• New 34-foot approach section similar in construction with the main bridge; • (1) span, 35-ft long; • (5) lines of standard WASDOT WF50G girders at the span; • (1) cast-in-place concrete pile caps, 5-foot deep by 6-foot wide by 50 feet long; • (5) concrete columns, 4-ft in diameter, at the pilecap; • (1) 7-foot drilled in concrete shaft at each column (see Geotechnical for shaft depth); • (1) Abutment with four drilled-in shafts, 7-foot diameter.

Design Criteria, Seismic: The bridge design shall include earthquake resisting systems (ERS) corresponding to the requirements of a Seismic Design Category (SDC) of C or D which is typical for the Puget Sound region. Determination of SDC is based on the parameters identified in the geotechnical content of this document (Section 1-4). Category D is more stringent of the two categories and a more complex analysis and detailing for structures subjected to this category will be required during PED. Category D requirements can lead to an increase in both the design and construction of the bridge.

On October 26, 2015 a State of Washington DoT State bridge and structures engineer indicated that "...the SR 101 corridor at Duckabush has the same life-safety requirements as bridges classified as "ordinary bridges' by AASHTO specifications." The required seismic performance objective for this bridge is therefore Life Safety (WSDOT Bridge design Manual Section 4.1). AASHTO Seismic Design guide specifications are intended for conventional bridges designed for the life safety performance objective considering a seismic hazard corresponding to a 7% probability of being exceeded in 75 years. This performance objective corresponds with a low probability of bridge collapse in a 1000-year event but the bridge may suffer significant damage, and significant disruption is possible. Partial or complete replacement of the bridge may be required.

For SD1 of 0.38g (See geotechnical), and based on AASHTO Table 3.10.6-1, the seismic zone for this bridge is zone 3. And according to AASHTO tables 4.7.4.3.1-2 this bridge does not qualify as a "Regular Bridge" due to its total length and localized spans and bridge curvature. For multi-span bridges that are not regular and fall in AASHTO seismic zone 3, a Multi Mode (MM) elastic seismic analysis is required (AASHTO Table 4.7.4.3.1-1). The MM elastic analysis will be more sophisticated and it may noticeably contribute to the overall cost of bridge design and construction.

Design Criteria, Gravity: The Bridge will be designed for loads from HL-93 (HS-20 Truck + 0.64k/ft lane) truck and its own self weight in accordance with AASHTO loading criteria.

Design Criteria, Hydraulic: A minimum distance of 3 feet from the Base Flood Elevation (BFE) to the bottom of the lowest point of bridge girders is selected in order to provide adequate clearance for debris in a BFE event. With the concept design bridge girder depth and deck thickness, the bridge deck should be at an elevation of about 26 feet with respect to the NAVD 88 datum. Subsequent design will evaluate the minimum clearance requirements for this site for large debris taking into account future sea level change projections identified in Section 1-2.1.9.

Summary of technical criteria / requirement is tabulated in Table 1- 7-2. The latest and most current edition of the specified criteria will apply at the time of final design.

Table 1- 7-2. Technical Requirements.

Item	Description
Design Specifications	• WSDOT Bridge Design Manual • AASHTO LRFD Seismic Bridge Design • AASHTO LRFD Bridge Design Specifications
Load Criteria	• Live Load: HL-93 (HS-20 Truck + 0.64k/ft lane), 1.3 Impact Factor • Pedestrian (if required): 75 psf • Dead: Concrete = 0.16 K/cu ft, Steel 0.49 k/cu ft. • Load Combinations: Per Table 3.4.1-1 LRFD (Load Combinations and Load Factors)

1-7.2 Survey, Hydrologic, Hydraulic, and Geotechnical Data Used

LiDAR survey and probable water surface elevations were used to develop the conceptual plan. For information about data used for the conceptual design, see Section 1-3.1.

No site specific geotechnical data were available at the time of this conceptual design. Numerous borings will he required to facilitate development of an accurate cross section of the geology below the bridge. For this conceptual design phase, typical uear shore soil characteristics of Puget Sound are used to select the bridge foundation type. Geotechnical investigations will be required for completion of PED; see Section 1-4.3.

1-7.3 Site Selection Studies

The site selection is discussed in Section 1-6.

1-7.4 Major Structures

General: The proposed State Highway 101 Bridge is the only major structure included in the proposed restoration of Duckabush River Estuary. The bridge superstructure consists of a reinforced continuous concrete deck supported by a series of standard AASHTO pre-cast, pre-stressed concrete girders. A concrete cap beam and two concrete columns are provided at each bent to support the girders. The concrete columns are supported by drilled-in concrete piers.

Superstructure: Pre-cast, pre-stressed concrete girders are fabricated of high-quality concrete and they are the most common type of girders used in state of Washington. Concrete girders require lower-maintenance than their steel counterparts and are competitively priced with steel girders. The economy in structural design can be achieved by designing around the standard girders from the Bridge Design Manual Span Capability Sheet.

Substructure: Deep concrete shafts are used in liquefiable soils, which are commonly found in the flat tidal zones of Puget Sound. The design objective is to extend the foundation shafts to a suitable bearing depth to provide the necessary lateral support for the structure during a seismic event. See Section 1-4 for additional information.

Technical Considerations: Several technical goals were taken into consideration in selecting the type of bridge recommended for the project, including: cost-effectiveness, functionality (traffic and hydraulic needs), and structural strength/safety. The proposed design incorporates a repetitive concept that incorporates standard structural components, leading to maximum economy for fabrication and installation. The geometric design facilitates the two-lane traffic requiremeuts and the selected spacing between the support bents and the deck height provide the opening that is required by hydrology.

Bridge Type recommended for this site is a pre-cast, pre-stressed concrete girder bridge tbat supports a continuous concrete deck. The girders are supported by cap beam which comprise the transverse beam of the pier system. The pre-cast girders will be fabricated offsite and shipped by truck to the site for installation. Standard WSDOT pre-cast concrete girders are an efficient and economical bridge type for continuous span construction.

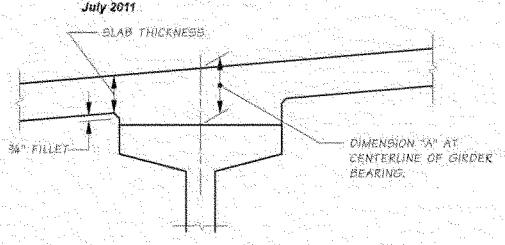
Span Length affects many aspects of the design. The overall thickness of the superstructure is a function of the span length, and the thickness of the superstructure relates to a vertical clearance need for flood conditions. The quantity of bridge piers/bents is another byproduct of the selected span. More bends require more construction as they create more constriction to the hydraulic flow. The selected approximate 120 foot span is considered to be a reasonable balance between economy, repetitiveness, constructability and functionality.

Depth of Structure: Total thickness of the superstructure is the sum of the "A" dimension and the girder depth. The "A" dimension is the thickness of concrete deck directly above the girder. Conceptual level design indicates that a WF50G standard AASHTO girder with a deck of 11.25 inches satisfies structural requirements. See Figure 2-7-1 below.

Alignment: (see Section 1-6, Civil Design)

Appendix 5.6-A1-2 Span Capability of WF Girders

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF50G	5	140	11.00	7.50	124
	6	135	11.25	7.50	119
	7	125	11.25	7.50	111
	8	120	11.50	7.50	107
	9	115	11.25	7.50	102
	10	110	11.25	7.50	98
	11	110	11.25	7.50	98
	12	105	11.50	8.00	94



Depths for Deck Slab Design at Interior Girder
Figure 5.7.1-1

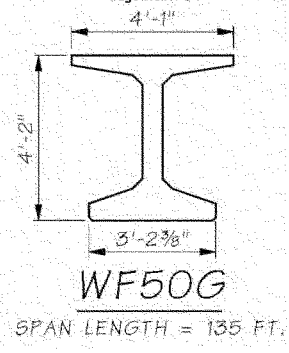


Figure 2-7-1. Detail of WF50G standard AASHTO girder dimensions.

1-7.5 Describe Evaluation and Selection of Substructure Alternatives Based On Economy and Performance

These bridges are located in an estuarine environment, likely requiring deep foundation as recommended by the geotechnical engineer.

The soils at this site are likely to experience liquefaction during an earthquake. As such, the shafts will have to extend to a suitable bearing depth for a solid fixed embedment.

The cost comparison between types of deep foundations (piles versus shafts) does not always result in a clear cost advantage for either foundation type. Many factors come into play such as availability of equipment to a contractor, a contractor's preferred method, the depth of the footing and the ease of access, construction schedule, and depth of foundation. In general, cost is not a determining factor for deep foundation type. Forces, displacement, and geological conditions will determine which system is best to use.

General and local scour is always a consideration with deep foundations. Subsequent design will include a hydraulic scour analysis. Protection of the structure from hydraulic scour may compete with the goals of the restoration. Preliminary design will evaluate these considerations and mitigate accordingly.

For additional information, see Section 1-2.

1-7.6 Construction Considerations

(See Section 1-6, Civil Design).

1-7.7 Stability Analyses

A precise numerical analysis of the bridge superstructure will be performed at the time the bridge design gets underway. At this conceptual stage of the design sufficient qualitative stability elements have been incorporated to ensure the bridge is stable in all three spatial directions. The recommended continuous bridge deck provides the superstructure with a continuous diaphragm. The deeply drilled-in reinforced concrete shafts provide the vertical and lateral stability of the bridge, and the concrete columns that connect the bridge superstructure to the substructure form a stable system for vertical and lateral load transfer to the substructure.

1-7.8 Stress Analyses

Stress analyses are a fundamental component in the design process and serve as the basis of how all strnctural elements are assembled to work together. Design shall be in accordance with governing standards of the WSDOT Bridge Design Manual and the AASHTO LRFD Manual.

1-7.9 Thermal Stress Analyses

Thermal analysis is a fundamental component of the design process and will be considered per the AASHTO LRFD design specifications. In general thermal stresses are handled by providing expansion joints in strategic locations to permit a bridge to expand and contract without a large buildup of stresses or movement.

1-7.10 Other Analyses

The conceptual design has been based on traffic requirements, hydraulic analyses, loading requirements of structures, and constructability considerations.

1-7.11 Additional Studies, Tests, Analyses

The information needed to design a bridge is generally captured in the following studies, tests, and analyses:

- Boundary and Topographic Survey
- Geotechnical Investigation and Report
- Hydraulic and Scour Analysis

Additional investigation and studies may be needed for permitting or other site requirements unrelated to the infrastructure. See Section 1-21 for a complete list of recommended additional studies and investigations.

1-8 ELECTRICAL AND MECHANICAL REQUIREMENTS

Electrical and mechanical structure requirements are not applicable to this site. Utility line relocations are discussed in the Section 1-6.3

1-9 HAZARDOUS AND TOXIC MATERIALS

A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.*

The assessment revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the Duckabush site.

1-10 CONSTRUCTION PROCEDURES AND WATER CONTROL PLAN

The proposed restoration will involve earthwork and exposure of bare ground excavation of channels. At this stage of design, it is assumed that standard best management practices will be implemented to control erosion and sedimentation and ensure construction areas are stabilized as needed to prevent adverse impacts. A standard temporary erosion and sediment control plan will be developed during PED.

Some in-water work may be required during channel creation. For channel creation, work will be sequenced to avoid in-water work as much as possible and most of the channel creation work will occur in the summer months prior to removal of the roadway embankment. For required in-water work, channel excavation will take place at low water to reduce the likelihood of releasing sediments into downstream waters and will make use of the temporary erosion and sediment control plan. Standard soil cover and stabilization practices will be implemented to stabilize the channels prior to introduction of water.

Specific measures for construction procedures and water control will vary depending on the location and nature of the work associated with the site. State and Federal resource agencies will impose specific timing restrictions on in-water work to protect fish and wildlife, and the Corps will adhere to conservation measures detailed in environmental compliance documents. In addition, specific measures may be required to protect downstream infrastructure or built environments. A complete description of best management practices will be determined during PED.

1-11 INITIAL RESERVOIR FILLING AND SURVEILLANCE PLAN

The proposal is for ecosystem restoration. (Not applicable.)

1-12 FLOOD EMERGENCY PLANS FOR AREAS DOWNSTREAM OF CORPS DAMS

The proposal is for ecosystem restoration. (Not applicable.)

1-13 ENVIRONMENTAL OBJECTIVE AND REQUIREMENTS

Feasibility-level information to develop designs, plaus, and specifications, and to execute construction and operations is included in the Project's supporting documents including the U.S. Fish and Wildlife Service report titled "Strategic Restoration Conceptual Design - Preliminary Environmental Contaminant, Cultural Resource, and Endangered Species Site Evaluations." The environmental information developed for the analysis in the FR/EIS provides additional environmental objectives and requirements for final site design development. As summarized in Section 1-6, Civil Design, substantial environmental information was developed for the FR/EIS regarding environmental problems, opportunities, and constraints such that the Corps could estimate costs of the restoration sites and prepare the Real Estate

Plan. The Corps will adhere to requirements stated in the Endangered Species Act consultation documents, Clean Water Act Section 401 certification, and other site-specific environmental compliance documents. The Corps has prepared a Programmatic Agreement (PA) for Section 106 of the National Historic Preservation Act compliance. As outlined in the PA, cultural resource investigations are necessary in the PED phase to determine if National Register eligible historic properties are located in the restoration project area prior to construction. The Monitoring and Adaptive Management Plan will be used to determine whether the site is meeting environmental objectives after construction.

1-14 RESERVOIR CLEARING

The proposal is for ecosystem restoration. (Not applicable.)

1-15 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R)

Operations and maintenance costs for the Duckabush estuary restoration are related to maintaining flow in the North channel, invasive species removal, and maintenance of the infrastructure components of culverts, the roadways, and the new Highway 101 bridge.

- Maintaining flow to the North Distributary Channel will involve debris removal, which is likely to accumulate after large storms when high river flows wash debris from upstream, and sediment removal if the crossing connection channel fills in to the point that flow is cut off from the channel on the north side of the estuary. This channel provides a significant amount of sediment distribution for maintenance of substrate for shellfish beds and provides a rearing and migration corridor for salmonids.
- Vegetation maintenance costs are primarily to prevent and eradicate invasive plant species. This will require annual monitoring and semi-annual treatments if invasive species are found on site. This project has no planting plan other than hydroseeding at the end of construction; therefore standard O&M of watering and replacement will not be needed on plants at this site. The purpose of the project is primarily to restore freshwater input and sediment transport processes to the intertidal zone where irrigation is not necessary. Native saltmarsh plants often recruit on their own where substrate conditions are provided.
- Yearly culvert inspection and maintenance includes removal of debris and sediment.
- Roadway & embankment inspection, maintenance and repair - Maintenance costs for roadways and road bridges were developed based upon the WSDOT Pavement Policy. It is assumed that roadways will be constructed with hot-mix asphalt, and that the maintenance of a particular road will occur as part of a larger effort that includes adjacent road sections. Repair and maintenance includes:
    - Roadway asphalt overlay twice during the 50-year period of analysis
    - Roadway grind and inlay once during the 50-year period of analysis
    - Roadway guardrails, signs and striping.

- Bridge maintenance - Bridges will be constructed using pre-stressed concrete girders which are commonly used due to their low maintenance costs. WSDOT staff indicated that the maintenance costs do not vary greatly by bridge length (Wilson, 2011 and Baroga, 2011). Maintenance activities will include:
    - Bridge inspection & cleaning every year 2 or 3 man crew for 1 week
    - Replacement of guardrails, retrofit and structural repairs.

Annual OMRR&R is estimated at $122,000 for the 50-year project period. Additional assessment of O&MRR&R activities will be conducted during PED.

1-15.1 33cfr Part 208 Projects

The site is not a flood control project to be maintained and operated according to regulations in 33 CFR 208. (Not applicable.)

1-15.2 Channel or Basin Clean Out Projects

The restoration does not include channel or basin cleanout activities. (Not applicable.)

1-15.3 Multiple-Purpose, Complex Projects with Power Production

No power production is proposed. (Not applicable.)

1-15.4 Frequency and Cost of Maintenance Dredging

No maintenance dredging is proposed. (Not applicable.)

1-16 ACCESS ROADS

Construction activities will require heavy equipment to be mobilized to the site. It is assumed access to the site during construction will utilize highway 101 and Duckabush road. Temporary traffic control is necessary during mobilization and site access activities. Construction sequencing should keep the fire station and Duckabush road open for 24/7 access. The area south of the fire station and the parking area to the south of the highway 101 bridge of the project are possible staging areas. Construction staging areas, site access and construction sequencing will be further analyzed during PED, after a cultural resource survey has been completed. Staging areas will be placed in locations that avoid impacts to cultural resources that may be identified during a cultural resources survey.

1-17 CORROSION MITIGATION

No new corrodible construction is proposed. (Not applicable.)

1-18 PROJECT SECURITY

The proposal is for ecosystem restoration. (Not applicable.)

1-19 COST ESTIMATES

The Duckabush River Estuary construction cost estimate of $90,523,000 (Mar 2016 dollars) consists of costs for removal of roadway embankment and bridges, channel excavation and construction of new bridges and roadway embankments. Other work includes culvert replacement and hydroseeding.

The largest cost driver is relocations including demolition of existing bridges and roadways and construction of new roads and bridges ($56,506,000 construction cost, Mar 2016 dollars). This work consists of all temporary construction facilities and platforms needed to construct the bridges as well as the new intersection with Duckabush Road, a private road and US Highway 101.

Following a formal cost and schedule risks analysis, a project contingency of 46% was developed. Primary engineering related cost risks came from the high uncertainty surrounding bridge and bridge foundation design. Minimal detail was provided in the design report and additional geotechnical and survey information will be required to constrain the uncertainty in these costs. The current estimate includes $500,000 for mitigation for removal of the Duckabush Bridge 101-266 which is on tbe National Register of Historic Places. Sbould additional National Register eligible cultural resources be identified during the

cultural resource survey and need to be mitigated then cost would rise to account for those mitigation costs. The cost risk register accounts for cultural and historical properties that may be impacted by the project. Also, there is a likelihood that newly built roadway embankments will settle and will require additional material to maintain the required roadway elevation. Schedule risks are controlled by the potential for work to need to stop during the rainy seasons and when in-water work is prohibited. Additional mobilizations and lost time would be incurred because of this.

There are non-cost related risks as well. There could be either erosion or sedimentation in excavated channels during river flooding. Channels will need to be watched following construction as part of the overall monitoring plan. Risks that do not directly affect cost include sedimentation of the distributary channels that lead to flow reduction or obstruction. Further analysis is needed in this area, and requirements could range from a monitoring plan to omission from the project scope.

Opportunities to reduce the project cost include a potential for reductions in material prices. Opportunities for this site for cost come from the possibility that bridge work may be substantially less expensive than predicted. This chiefly comes from the standardized designs used throughout PSNERP for bridges. Foundation piers were all designed very conservatively, and may be reduced with additional analysis. Schedule opportunities come from the same issue. The PDT considered it likely that there could be schedule reductions from lowered requirements.

1-20 SCHEDULE FOR DESIGN AND CONSTRUCTION

The proposed restoration at the Dnckabush River Estuary is considered to be relatively straightforward. Based on the low level of complexity, the anticipated design period for the site is approximately two years. This includes preparation of final design, plans and specifications, and the construction contract.

The anticipated construction period for construction of the new bridges and roadway embankments, channel excavation, and removal of existing bridges, roadways and embankments is approximately three years. Any in-water construction activities will take place during established work windows. Road and bridge elements would need to be phased in a manner that allows for continuous access across the estuary on Highway 101.

Property acquisition and environmental compliance timelines are not included in this duration. The time required to complete these upfront activities is nnknown, bnt is assumed to be relative to the length of the anticipated design period for the site as described above.

1-21 STUDIES TO BE COMPLETED IN PED

Table 1-21-1summarizes recommended studies and additional investigations to be conducted at the site to support subsequent stages of design and implementation. Unless otherwise noted, these studies are recommended to take place during PED. In the table, studies are classified according to the following purposes:

- Data required for design, cost estimation or project compliance,
- design analysis to minimize project construction costs,
- design analysis to optimize environmental benefits,
- identification of induced flooding,
- and identification of actions needed for O&M.

Table 1-21-1. Studies Recommended for the Duckabush River Estuary Site

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Property Investigation/Survey	• Compile more detailed information on parcel ownership and property boundaries to finalize the design, confirm acquisition requirements, and support negotiations with property owners.	X	X			
Topographic/ Planimetric/ Bathymetric Survey	• Complete site-specific topographic and bathymetric surveys to refine design of key elements, confirm that target elevations are appropriate for the desired ecosystem components (low marsh, etc.), develop detailed construction and demolition plans, and provide a baseline for pre- and post-construction modeling, including hydrodynamic modeling.	X				
	• If needed, install a temporary tide gauge in the early design stages to obtain site-specific tidal statistics.	X				
Hydraulic Analysis/Modeling	• Implement a hydraulic model for the Duckabush River and Estuary reflecting the proposed geometry to predict the with-project water surface profiles and confirm the extent and nature of hydraulic effects from the project.		X	X	X	X
	• Combine review of aerial photographs with field surveys to quantify channel topology and hydraulic roughness and inform geomorphic evaluation under restored conditions.	X				
	• Assess hydraulics and effects of increased tidal prism to quantify effects on adjacent shores.		X	X		X

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Hydraulic Analysis/Modeling (cont.)	• Evaluate changes in salinity and flow patterns within, adjacent to and downstream of the site, if required.			X		
	• Formulate the detailed monitoring plan, including any required field surveys or instrumentation that will be used to evaluate the project's hydraulic performance.			X		X
Sedimentation Analysis/Modeling	• Analyze potential channel infilling and evolution of channels to determine long-term stability of the site.			X	X	X
	• Evaluate temporary increases in sedimentation downstream of the site during the establishment of new distributary channels to evaluate effects and fine tune channel design.		X	X		X
	• Perform a scour analysis to predict the range of scour at the new bridge piers and abutments.		X			
Coastal Engineering Studies	• Refine sea level projections using localized tide gauge data.	X				
	• Review and establish the final design tidal datums		X			
	• Conduct wind direction and run-up analyses to confirm coastal BFE.		X	X	X	
Geotechnical Investigation	• Complete a standard investigation to include subsurface explorations, testing, and field reconnaissance.	X	X			
	• Confirm borrow and disposal sites.	X				
	• Complete additional geotechnical study and recommendations to finalize design of levees, roads, and bridges.		X			
	• Perform a settlement analysis for roadway embankments.		X			
Foundation Design Study	• Perform static and seismic analysis according to AASHTO LRFD for vehicle bridges.		X			
Abutment Stability Study	• Evaluate the potential for liquefaction and ground improvement.		X			
Excavated Materials Study	• Evaluate the suitability of excavated materials for reuse.	X	X			

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Pavement Design Study	• Complete a pavement design study for new roadways and approaches (include traffic analysis for ESALs).		X			
Structural Engineering	• Structural analysis of the bridge, bridge piers, and foundation.		X			
	• Analysis for gravity, wind and seismic effects.		X			
	• Design of bridge deck and supporting structure for gravity, wind and seismic effects in accordance with criteria established in this report.		X			
Utility Survey	• Compile more detailed information on utilities to finalize the design and confirm acquisition requirements.	X	X			
Cultural Resources Investigation	• Complete surveys for archaeological and historic resources, particularly in areas proposed for excavation. If required, consider various mitigation measures for the removal of the National Historic Register listed Duckabush Bridge.	X	X	X		
Wetlands Investigation	• Document the location, extent, and character of wetlands.	X		X		
Cost Study	• Assess potential for cost and schedule reductions during refinement of restoration design.		X			
Environmental Compliance	• The Corps will coordinate with all relevant natural resource agencies during PED. Results of PED-phase studies will be provided to agencies and tribes as appropriate.			X		

1-22 DATA MANAGEMENT

Project documents, background materials, and digital files from the local sponsors were provided to the project team directly, through the State's Habitat Work Schedule, or via the Nearshore Portal. The project team also used databases previously developed by and for the Puget Sound Nearshore Ecosystem Restoration Project including the Change Analysis and backing geospatial data (see Section 1-3.1.1 for additional detail).

Work products for the conceptual restoration designs were developed primarily in GIS and typical word processor and spreadsheet applications. GIS products for all action areas were collected in a single geodatabase that captured spatially referenced locations and sizes of major design elements.

1-23 USE OF METRIC SYSTEM MEASUREMENTS

This report uses United States customary units for design and construction measurements. To remain consistent with work conducted to date, the metric system of measurement was not used.

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ANNEX 1-1: EXHIBITS

This annex contains a set of site-specific exhibits prepared for the proposed restoration. The exhibits include:

Exhibit A – Conceptual Design Plan

Exhibit B – Conceptual Design Sections

Exhibit C – Phase 1 Environmental Site Assessment

Exhibit D - Preliminary Foundation Axial Capacity Estimate Worksheet

Exhibit A

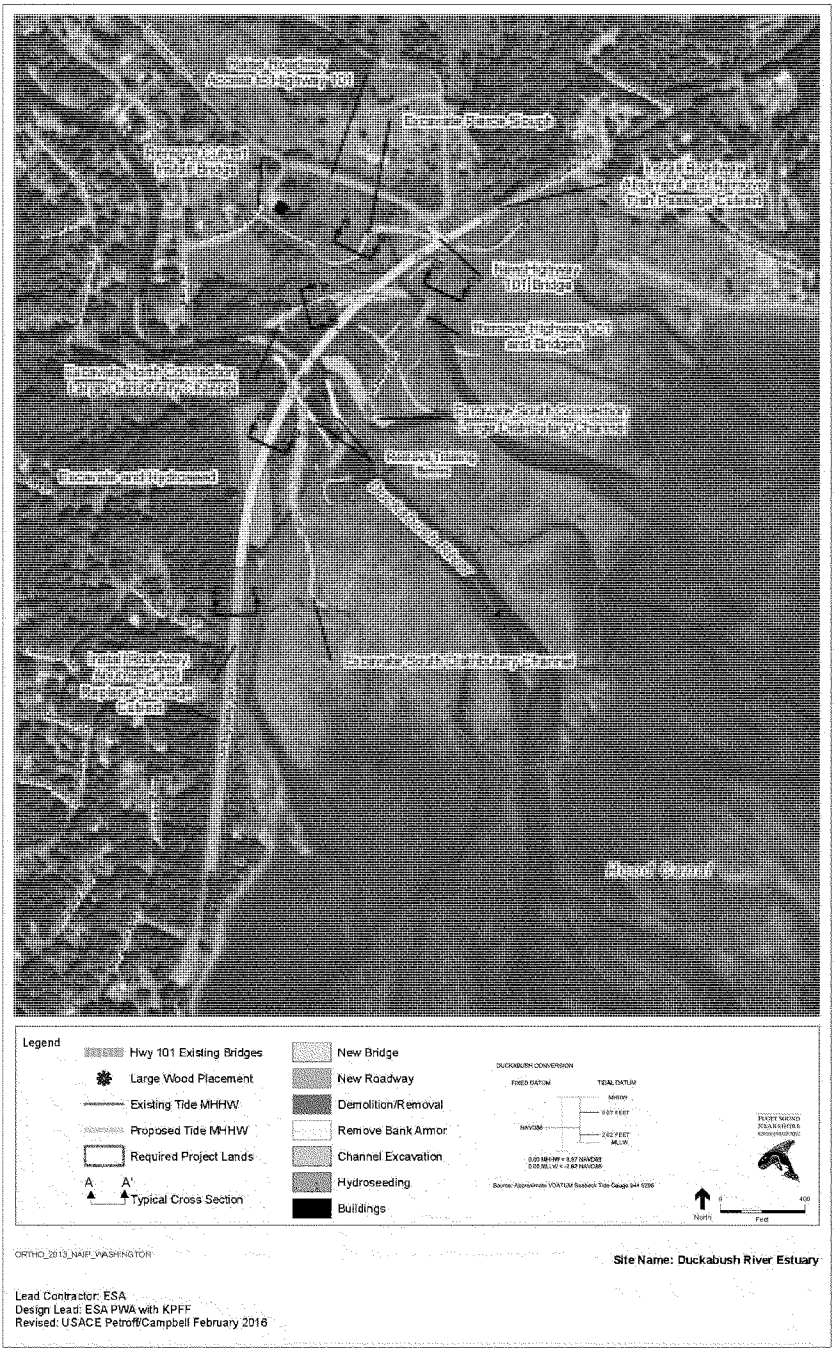
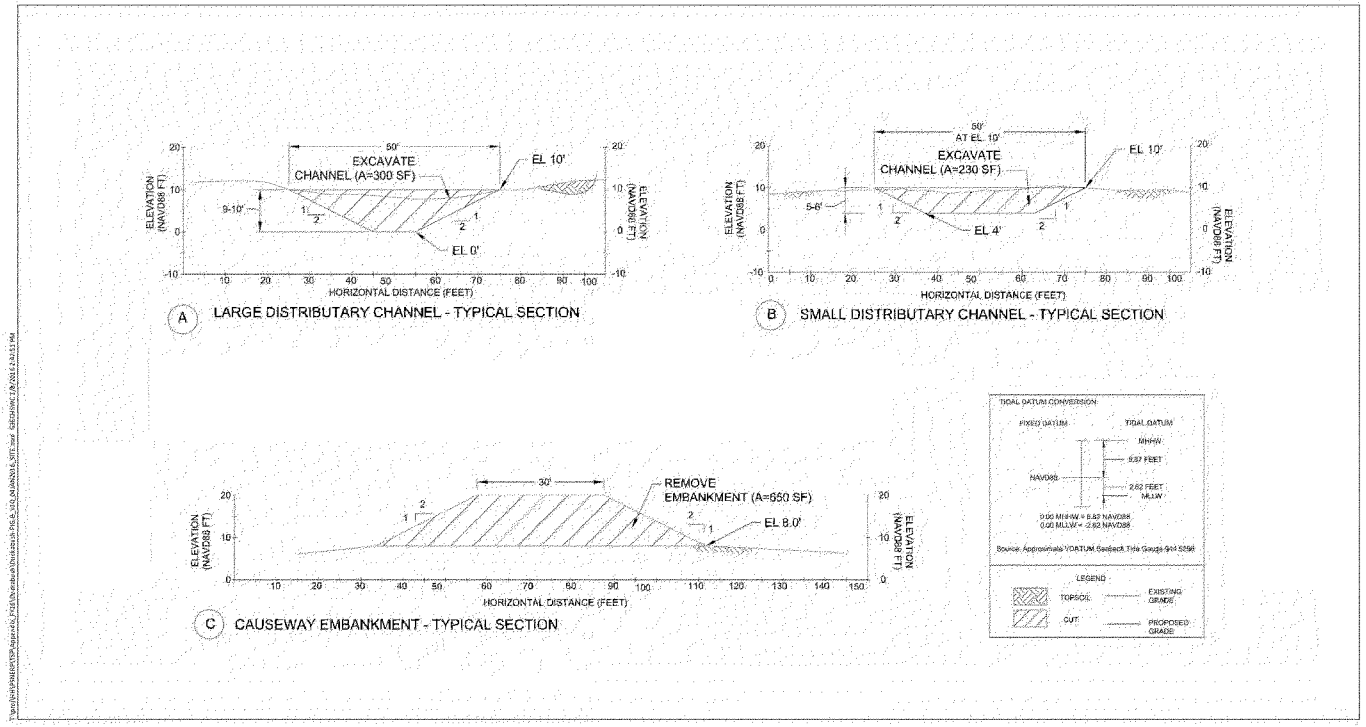

Legend
Hwy 101 Existing Bridges
Large Wood Placement
Existing Tide MHHW
Proposed Tide MHHW
Required Project Lands
A A'
Typical Cross Section
New Bridge
New Roadway
Demolition/Removal
Remove Bank Armor
Channel Excavation
Hydroseeding
Buildings
DUCKABUSH CONVERSION
FIXED DATUM
TIDAL DATUM
MHHW
9.67 FEET
NAVD88
2.62 FEET
MLLW
North
Feet
ORTHO_2013_NAIP_WASHINGTON
Site Name: Duckabush River Estuary
Lead Contractor: ESA
Design Lead: ESA PWA with KPFF
Revised: USACE Petroff/Campbell February 2016

Exhibit B

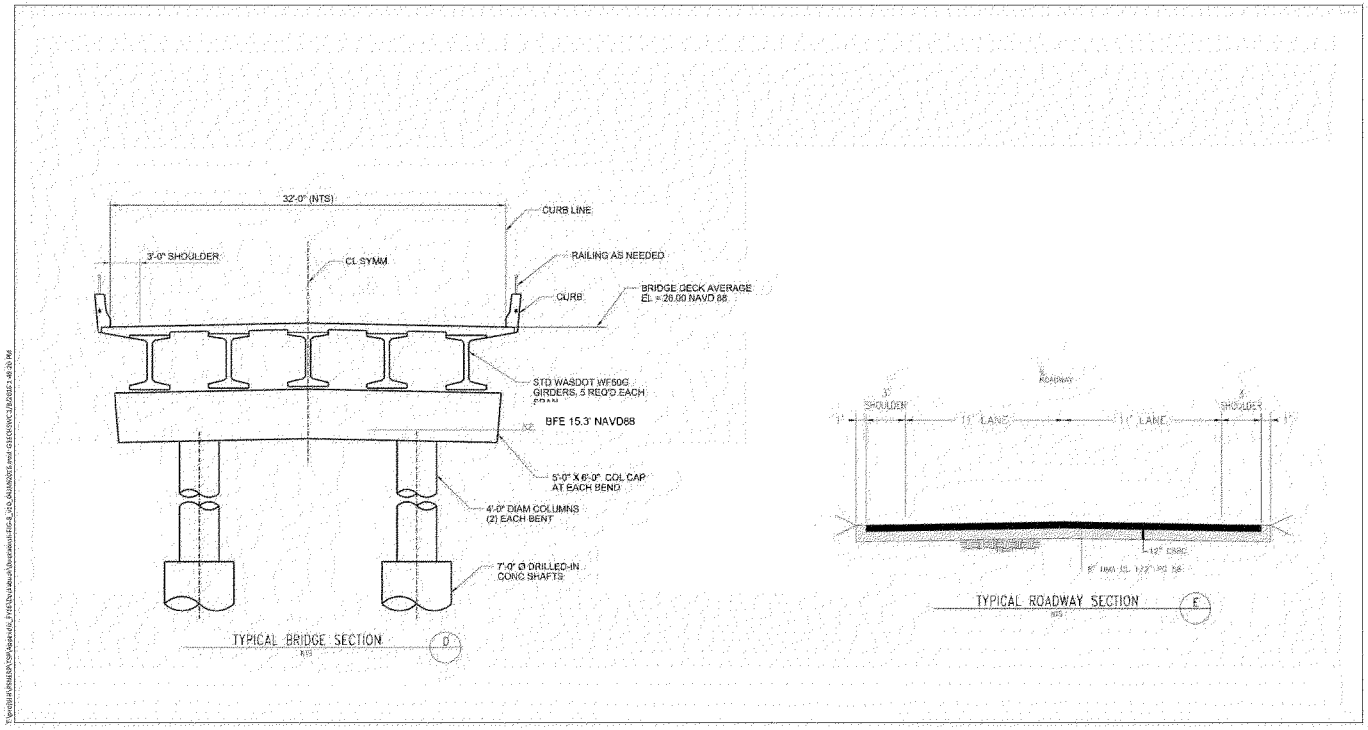


ORTHO_2013_NAIP_WASHINGTON

Site Name: Duckabush River Estuary

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit B



ORTHO_2013_NAIP_WASHINGTON

Site Name: Duckabush River Estuary

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit C

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT FEASIBILITY STUDY HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

EXECUTIVE SUMMARY

The Seattle District Corps of Engineers (Corps), working collaboratively with the Washington Department of Fish and Wildlife (WDFW) as local sponsor, along with many other regional partners, has conducted a General Investigation (GI) to evaluate problems and potential solutions of ecosystem degradation and habitat loss in Puget Sound, Washington. The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). The Corps and local sponsor are recommending implementation of restoration actions at three sites throughout the study area as the outcome of the Nearshore Study. Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, the U.S. Army Corps of Engineers is preparing an Integrated Feasibility Report/Environmental Impact Statement (FR/EIS) for the three restoration actions. The Phase 1 Environmental Site Assessment for the Duckabush Estuary site is being conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects,* except where noted below.

The assessment revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site.

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Exhibit C

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT FEASIBILITY STUDY HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

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1.0 INTRODUCTION

1.1 Involved Parties

The Corps is the lead Federal agency for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Report. The non-Federal, cost-sharing sponsor is the Washington Department of Fish and Wildlife (WDFW). As the non-Federal sponsor, WDFW contributes 50 percent of the total feasibility study costs in the form of cash or in-kind contributions; a feasibility cost sharing agreement was executed in 2001, with amendments.

1.2 Authority

The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874).

1.3 Guidance and Policy

Corps policy providing guidance for consideration of issues and problems associated with hazardous, toxic, and radioactive wastes (HTRW), as defined in this regulation, which may be located within project boundaries or may affect or be affected by Corps Civil Works projects is contained in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects*, which defines HTRW as "...any material listed as a 'hazardous substance' under the Comprehensive Environmental Response, Compensation, Liability Act (CERCLA)". ASTM International (ASTM) Standard E 1527-13 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* provides a comprehensive guide for conducting an HTRW Assessment. An assessment identifies known or suspected releases of hazardous substances (recognized environmental conditions) based on records review, site visit, and interviews.

1.4 Scope of Work

The complete investigation serves to identify any recognized environmental condition, as defined in ASTM Standard E 1527-13. This site assessment documents known and suspected HTRW sites discovered through a search and review of all reasonably attainable federal, state, and local government information and records. A site visit, interviews with relevant stakeholders, and review of aerial photographs are also mandated under the above standard.

1.5 Significant Assumptions

This report identifies known and suspected environmental concerns, both past and present based on availability of information at the time of the assessment. It is possible that unreported disposal of waste or illegal activities impairing the environmental status of the properties may have occurred which could not be identified.

1.6 Limitations and Exceptions

This document deviates slightly from the exact procedures outlined in ASTM E1527-13. Specifically, no "User Provided Information" nor "Non-Scope Services" were provided, and those sections of the report were omitted. Also, due to the layout of the overall document to which this report will be incorporated, it was decided that no appendices were to be generated for this report. Additionally, it should be noted that portions of this report were conducted by separate entities that did not have the ability to coordinate their efforts. However, this does not change the results or outcome of the report.

1.7 Special Terms and Conditions

No special terms or conditions with respect to ER 1165-2-132 and ASTM E 1527-13 standards were made.

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1.8 User Reliance

In accordance with ASTM E 1527-13 Section 7.5.2.1 "Reliance," the environmental professional is not required to independently verify the information provided by various sources but may rely on the information unless there is actual knowledge that certain information is incorrect or unless it is obvious that certain information is incorrect based on other information obtained during the course of the investigation or otherwise actually known to the investigators conducting the assessment. At the present time there is no indication that the information provided by the database search is incorrect.

2.0 SITE DESCRIPTION

2.1 Location and Legal Description

The "property", as defined by the referenced ASTM standard, in this case includes several different properties in the Duckabush River Estuary. For the purposes of this assessment, the proposed Duckabush project footprint will serve as the "property" under review (See Figure 6-2 in the main body text).

2.2 Site and Vicinity General Characteristics

The physical setting of the subject property and vicinity is detailed in Section 6.1.1 of the main feasibility report. According to Department of Ecology (Ecology) well logs, depth to groundwater immediately northwest of Shorewood Rd. is anywhere from 4-10 ft. below ground surface. Given this information, it can be inferred that groundwater elevations farther south in the estuary are even lower.

The project footprint consists of a large portion of the Duckabush River delta, covering the main stem, several distributary channels, intertidal marshes, and two bridges of Highway 101. The footprint is predominantly used as a wildlife protection area, and there has been little to no development or construction in the footprint due to the estuary's transitory nature and frequent flooding. The beaches in the estuary may have been used for commercial oyster and Manila clam aquaculture in the past, and currently WDFW allows visitors to harvest shellfish on a small scale.

3.0 RECORDS REVIEW

3.1 Standard Environmental Records

A records search was conducted on September 25, 2015, using a variety of sources. The primary sources included EPA's National Priority List Mapper, EPA's EnviroFacts database, Ecology's Toxics Cleanup Program (TCP) database, and Ecology's Facility/Site database. Below are the parameters and results of the records search.

Parameter	Source	Minimum Search Distance (mi.)	Results
Federal NPL	EPA NPL Mapper	1	None
Federal Delisted NPL	EPA NPL Mapper	0.5	None
Federal CERCLIS	EnviroFacts	0.5	None
Federal RCRA Generators	EnviroFacts	Property and Adjoining Properties Only	1 finding (Pereles Herrera)

Exhibit C

Federal RCRA TSDs	EnviroFacts	0.5	See above
Federal RCRA Corrective Action Sites	EnviroFacts	1	See above
Federal and State ICs Registry	Ecology TCP	Property Only	None
Federal Toxic Release Inventory	EnviroFacts	0.5	None
State and Tribal Cleanup Sites	Ecology TCP	1	None
State and Tribal Landfills and/or Solid Waste Disposal Facilities	Ecology Facility Search	0.5	None
State and Tribal UST Registry	Ecology TCP	Property and Adjoining Properties Only	None
State and Tribal LUST	Ecology TCP	0.5	None
State and Tribal Brownfields	Ecology TCP	0.5	None

The initial record search shows one permitted hazardous waste generator (the Pereles and Herrera site) approximately a tenth of a mile north of the footprint, along the mainstem of the Duckabush River. However, further investigation indicated that the permit is inactive, the property has since been sold to another owner, and an aerial investigation spanning the past 75 years shows no indication of current or past commercial or industrial activity.

3.2 Historical Records

Historical aerial photographs on Google Earth were reviews, along with historical maps from the U.S. Forest Service (USFS), and various documents provided by the Washington State Department of Fish and Wildlife (WDFW).

An examination of a 1923 USFS map of the Olympic Peninsula shows that a narrow gauge logging railroad was built from Brinnon up the watershed into what is now Olympic National Park. Further investigation attributed the railroad to the Webb Logging Company, which built the line in or around 1910. The railroad appears to turn northeast as it approaches the Duckabush estuary coming down from the hills, and probably passed a quarter of a mile north of the project footprint. The Webb Logging Company stopped logging in the Duckabush in 1929, and the railroad was not shown on subsequent USFS maps.

A 2001 document entitled *Brinnon Subarea Plan: A Chapter of the Jefferson County Comprehensive Plan* mentions that the Town of Brinnon used to have a solid waste transfer station on Duckabush River Road that was subsequently closed by Jefferson County. It is unclear whether the document is referring to Duckabush Rd. or River Rd. An aerial photograph search shows no obvious locations for such a facility, and further document searches did not find any subsequent references.

Exhibit C

3.3 Additional Environmental Record Sources

There are no additional environmental record sources included in this assessment.

4.0 SITE RECONNAISSANCE

A site visit was conducted on September 29, 2010 by Rich Carlson, a biologist at the USFWS. The reconnaissance found that development in the areas adjacent and near the project footprint is almost exclusively residential, except for a fire station, the two bridges, and fill associated with the Highway 101 grade. The two bridges are both made of steel and concrete, and are not painted. All other observations were confirmed by the record search.

An interview was conducted by Rich Carlson of the USFWS on September 29, 2010 with Richard Brocksmith of the Hood Canal Coordinating Council and Neil Werner with the Hood Canal Salmon Enhancement Group. No substantive record of this interview exists.

In order to query the current land owner, a further interview occurred on October 8, 2015 with Shane Belson, WDFW Site Manager of the Duckabush Wildlife Unit. Below is a record of that interview.

Interview Record				
Site:	Duckabush River Estuary, PSNERP			
Interview Type: Phone Location of Visit: N/A Date: October 8, 2015 Time: 230pm				
Interviewers				
Name		**Title**	**Organization**	
David Clark		Remediation Biologist	CENWS-EN-TS-ET	
Interviewees				
Name	**Organization**	**Title**	**Telephone**	**Email**
Shane Belson	WDFW	Site Manager	360-480-9105	N/A

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Exhibit C

Summary of Conversation
OBJECTIVE: The objective of the interview is to obtain information indicating presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment 1. The current use of the property is a wildlife protection area. What is your knowledge of prior uses of the project area? - Property was acquired in 1997 by WDFW. Respondent had heard talk of past shellfish harvesting in estuary, although most likely not at a commercial level. Respondent had removed a sign from the parking area that said "Twin Eagle RV Park", implying that an RV park had been located there before acquisition. Recommended following up by looking at the WDFW management plan for the Duckabush Unit. 2. What is your knowledge of prior and current uses of adjacent properties to the project area? Any industrial activity? Any cleanups? - No current or historical industrial activity on or adjacent to WDFW property. Current land use is residential in some areas, and conservation in others, mostly the estuary. 3. Tell me about the parking area to the south of the 101 bridge; does WDFW own that property? Have any spills or releases occurred in that area? - See the answer to question 1. WDFW currently owns this area. 4. Are you aware of any releases to the project area or surrounding areas? (Spills, etc.) Do you know of any chemicals that were used or stored on the property? - No. 5. Are you aware of any environmental reports written for the project area or surrounding areas? Such as, Environmental site assessment reports, environmental compliance audit reports, environmental permits (HW disposal permits, NPDES permits, etc), community right-to-know plans, risk assessments, etc. - No. 6. Any other information that might be pertinent to the site assessment? - No.
Additional Site-Specific Information
- The Corps will follow up on the possibility of the Twin Eagle RV Park being located in the now-WDFW parking area, and by reviewing the WDFW Duckabush Management Plan. - Management Plan – No additional information - Joe Leonard of Waketikeh Creek (later Joe Leonard Oyster Co.?) harvested oysters in Duckabush. Currently, Olympic Canal Tracts Owners Association has explored placement of geoduck seed.

Upon completion of the interview, further research was conducted to gather more information about the potential past location of the Twin Eagle RV Park on the current WDFW parking area, which is in the proposed project footprint. The WDFW Duckabush Unit Management Plan contained no further information concerning a past RV park, and further records of the RV Park's existence cannot be located.

Another key piece of information gleaned from the 2015 interview is the statement that the adjacent areas to the footprint do not, and most likely have not, contained any sort of industrial activity.

Exhibit C

5.0 FINDINGS AND CONCLUSION

This Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.* The assessment was initially conducted by Rich Carlson of the USFWS in 2010, and completed by David Clark, remediation biologist at the U.S. Army Corps of Engineers (Corps) in 2015.

This assessment has revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site.

6.0 SOURCES

ASTM E1527-13: *Standard Practice for Environmental Site Assessments.*

Engineer Regulation 1165-2-132: *HTRW Guidance for Civil Works Projects.*

Environmental Protection Agency. 2015. "Cleanups in my Community." http://www2.epa.gov/cleanups/cleanups-my-community

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United States Forest Service. 1998. *Duckabush Watershed Analysis.* Hood Canal Ranger District.

Washington State Department of Ecology. 2015. Toxics Cleanup Program Web Reporting. https://fortress.wa.gov/ecy/tcpwebreporting/Default.aspx

Washington State Department of Ecology. 2015. Facility/Site Database. http://www.ecy.wa.gov/fs/

Washington State Department of Fish and Wildlife. 2006. *South Puget Sound Wildlife Area Management Plan.*

Washington State Department of Fish and Wildlife. 2015. Public Clam and Oyster Beaches: Duckabush. http://wdfw.wa.gov/fishing/shellfish/beaches/270286/

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Exhibit D

Preliminary Foundation Axial Capacity Estimate					
Project	Duckabush Bridge				
Date	4 November 2015				
Parameter	***Value***	***Unit***	***Definition***	***Equation***	***Reference***
Dead Load Estimate					
L_{bridge}	2100	ft	total length of bridge	user input	-
N_{spans}	18	-	number of spans	user input	-
L_{span}	120	ft	length of largest span (length in calc)	user input	-
N_{lanes}	2	-	number of lanes	user input	-
W_{bridge}	34	ft	width of bridge	user input	-
D_{deck}	0.700	ft	thickness of deck	user input	-
$W_{pile\ cap}$	6.0	ft	width of pile cap	user input	-
$D_{pile\ cap}$	5.0	ft	depth of pile cap	user input	-
M_{girder}	1.0	k/ft	approx. weight/LF of girder	user input	-
N_{girder}	5	-	number of girders	user input	-
$\gamma_{concrete}$	0.160	kcf	unit weight of concrete	-	-
P_{dead}	1,220	kips	unfactored dead load	sum of bridge weight	-
Live Load Estiamte					
M_{truck}	72	kips	truck load estimate	user input	-
LL_{lane}	0.64	k/ft lane	live load per ft per lane	user input	-
P_{live}	226	lb	unfactored live load	sum of live loads	-
Load Combination					
DL	1,525	kips	dead load, strength I	$DL = 1.25P_{dead}$	(2) table 10-4
LL	395	kips	live load, strength I	$LL = 1.75P_{live}$	(2) table 10-3
P_U	1,920	kips	combined load, AASHTO LRFD 2010	$P_U = DL + LL$	-
Shaft Geometry and Various Parameters					
B_b	84	in	base diameter of drilled shaft	user input	-
D	135	ft	depth to bottom of shaft	user input	-
# of Piles	2	-	Number of piles per pier	user input	-
A_t	38.48	sf	toe-bearing contact area	$A_t = (B_b/12/2)\text{^}2 \times pi$	-
A_s	2969	sf	side-friction contact area	$A_s = (B_b/12) \times pi \times D$	-
γ_{soil}	0.1	kcf	unit weight of soil considered (average	user input	
γ_w	0.0624	kcf	unit weight of water	-	-
Base Resistance Estiamte (O'Neill and Reese, 1999) - N-value method					
N_{60}	15	blows/6"	SPT N-value $2B_b$ below the toe	user input	-
q'_t	18	ksf	net unit toe-bearing resistance	$q'_t = 1.2\ N_{60} \leq 60$	(1) equation 14.6
φ_s	0.4	-	resitance factor	user input	(2) table 10-5
P_t	277	kips	toe-bearing resistance	$P_t = \varphi \times q'_t \times A_t$	-
Side Resistance Estiamte (O'Neill and Reese, 1999) - Beta method					
z	67.5	ft	depth to midpoint of soil layer	z = D/2	-
σ'_z	2.54	ksf	average vertical effective stress	$\sigma'_z = z \times (\gamma_{soil} - \gamma_w)$	-
β	0.25	-	beta ($0.35 > \beta > 0.25$) for clays	user input	(1) section 14.3
f_s	0.63	ksf	unit side-friction resistance	$f_s = \beta \times \sigma'_z$	(1) equation 14.22
φ_s	0.45	-	resitance factor	user input	(2) table 10-5
P_s	848	kips	side-friction resistance	$P_s = f_s \times A_s$	-
Load Demand and Capacty					
Q_{des}	960	kips	Estimated static load demand / pile	-	-
Q_{all}	1,125	kips	Estimated pile load capacity	$Q_{all} = (P_t + P_s)$	(1) equation 13.1
$Q_{des} \leq Q_{all}$	**OK**	-	Design Load ≤ Load Capacity	-	(1) equation 13.5

References: *(1) Coduto, Donald P., Foundation Design: principles and practices, 2nd ed., 2001.*
(2) FHWA, Drilled Shaft: Construction Procedures and LRFD Design Methods, May 2010

Section 2 – Nooksack River Delta

Section 2: Nooksack River Delta

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2-1 GENERAL – NOOKSACK RIVER DELTA

2-1.1 Overview of Restoration Site

The Nooksack River originates on and around Mt. Baker, a 10,700-foot-high peak in the Cascade Mountains. In the upper watershed, three main forks converge before the river enters the flatter, agricultural lowlands. The Nooksack River Delta is centered on the Lummi Nation lands north of Bellingham in the San Juan/Georgia Strait Sub-basin. The restoration site encompasses nearly all of the Nooksack and Lummi River Estuaries below Ferndale.

The flow path of the Nooksack River has been modified since the mid-19th century beginning with active removal of large wood, draining, diking, and levee construction, which forced almost all flow to the east side of the delta. Prior to 1860, the Nooksack River emptied into both Lummi and Bellingham Bays with flows shifting between the two outlets over time, depending on logjams. In the late 1800s, the Nooksack River was diverted to drain into Bellingham Bay (Collins and Sheikh 2003).

This shift of the lower Nooksack River virtually eliminated migration of stream channels over the Lummi River delta (Bortleson et al. 1980). Early General Land Office mapping (circa 1887-1888) shows that significant meandering channels and intertidal habitats existed on both sides of the Lummi Peninsula. Today, substantial surface water diversions, groundwater withdrawals, and drainage activities within the Nooksack River watershed also impact the magnitude, tiining, and duration of surface water flows in the Nooksack River.

The Nooksack River Delta site was selected to address river delta restoration objectives to protect and restore freshwater input and tidal processes where major river floodplains meet marine waters. Target ecosystem processes include:

- Tidal flow
- Freshwater input (including alluvial sediment delivery)
- Erosion and accretion of sediments
- Distributary channel migration
- Tidal channel formation and maintenance
- Detritus recruitment and retention
- Exchange of aquatic organisms

The proposed restoration would modify levees, roads, and other hydrological barriers to restore riverine and tidal flow as well as sediment transport and delivery processes throughout a substantial portion of the historical Nooksack River delta. Construction of new setback levees would provide flood risk management for active businesses, residences, farms, transportation infrastructure, and Lummi Nation lands in the project area. The conceptual restoration plan for the Nooksack River Delta has the following main elements:

- Armor removal for streambank restoration and reconnecting floodplain habitat
- Dike removal or modification for floodplaiu freshwater marsh restoratiou
- Setback levees for floodplain reconnection and side channel development
- Riparian revegetation for shading, nutrient inputs, and complexity of bank habitat
- Large wood placement for increased habitat complexity
- Hydraulic modification: partial restoration of river flow to Lummi River through installation of water control structure at confluence of Lummi and Nooksack Rivers; structure intended to facilitate transfer of freshwater and sediment to the Lummi River
- Topography restoration: regrading of the Lummi River to allow for more frequent engagement by fluvial flows from the upper watershed
- Non-structural measure: residential relocations

Details of the restoration design are provided in Section 2-6 and shown on the exhibits provided in Annex 2-1. Figure 2-1-1 shows the Nooksack River Delta site and vicinity.

For the discussion in this Engineering Appendix chapter, the term Nooksack River Delta is taken to mean both the Nooksack River, the Lummi River (also known as the Red River) and their estuaries.

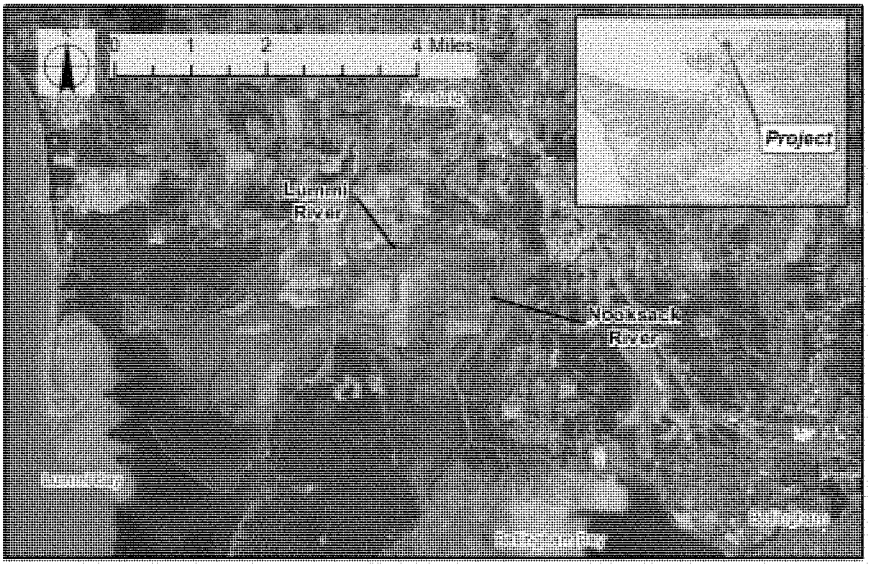

Figure 2-1-1. Nooksack River Delta and Vicinity

2-2 HYDROLOGY AND HYDRAULICS

The Nooksack River watershed (Figure 2-2-1) covers 950 square miles ranging from sea level up to the glaciers of Mt. Baker, a Cascades mountain range peak of 10,781 feet. In the upper watershed, three main forks converge before the river enters low gradient, agricultural lowlands. The Lummi River, located in the lowland estuary, was the main discharge route for the Nooksack Watershed until the mid 1800s (Collins and Sheikh 2003). The Lummi River is now mostly disconnected from the Nooksack River and only receives occasional limited flows from the Nooksack through a partially collapsed culvert. In the area of the junction between the two rivers, the active sedimentary environment has resulted in a grade difference between the Nooksack and the Lummi Rivers, making the reestablishment of a hydraulic connection difficult. The Nooksack River currently discharges to Bellingham Bay while the Lummi River discharges to Lummi Bay. Estimated annual rainfall averaged over the watershed is 78.5 inches.

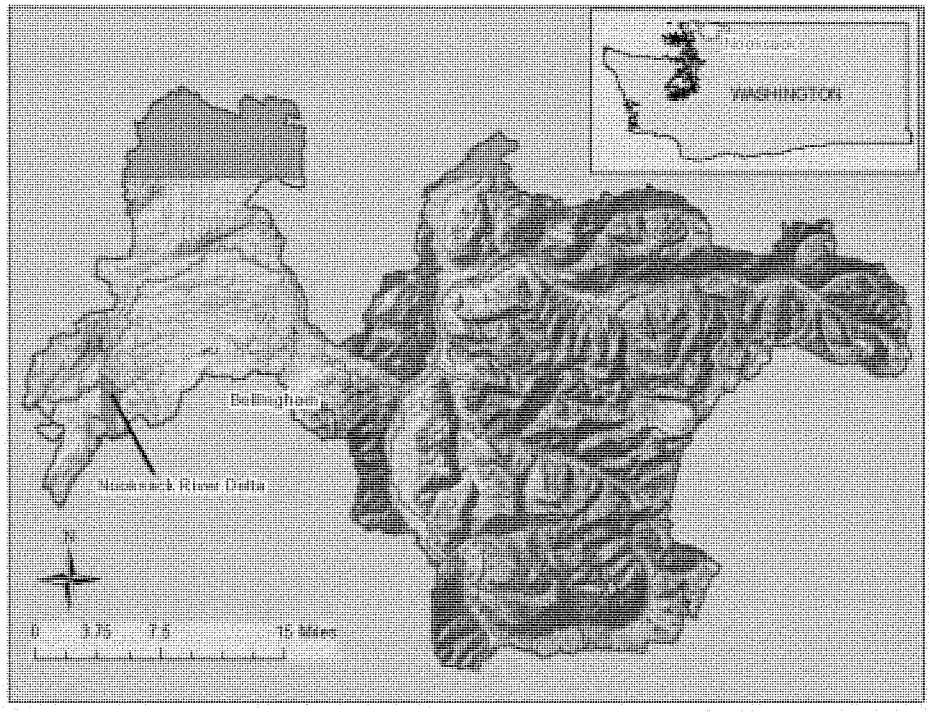

Figure 2-2-1. Nooksack River Watershed

The project site encompasses portions of the Nooksack and Lummi River Estuaries downstream of the city of Ferndale, Washington. It covers parts of the Lummi Nation lowlands as well as agricultural land south of Ferndale. Almost the entire project area lies below the 100-year flood elevation. The hydraulic intent at this site is to restore aspects of natural river and tidal flow to the Nooksack and Lummi Estuaries. The proposed work at this site is intended to increase the frequency of flooding in uninhabited riparian areas. Flood impacts will be mitigated by use of levee setbacks, raised roadways and the installation of flow control structures. The restoration is not anticipated to affect the 100-year or 500-year return interval flooding. No new riverside levees are planned for this site; however, new setback levees are planned. Since the planned setback levees and the setback of the North Red River Road may alter the flooding pattern from riverine and coastal flooding in the estuary, there may be some net changes in flowage easements.

The hydraulics and hydrology for all restoration sites in the Puget Sound Nearshore Ecosystem Restoration Project were evaluated using an area of potential hydraulic effects specific to the construction requirements for each particular site. The upstream and lateral limits for this area represent the 100-year base flood elevation derived from a combination of Federal Emergency Management Agency (FEMA) flood maps and Flood Insurance Studies as well as U.S. Army Corps of Engineers (USACE) base flood elevation determinations. Downstream and seaward limits are based on changes in shoreform type and best professional judgment.

Figure 2-2-2 shows the area of potential hydraulic effects for the Nooksack River Delta. The upstream and lateral limits were set according to the 100-year base flood elevation as determined by the FEMA Flood Insurance Rate Maps for unincorporated Whatcom County, community 53073C (revised 2004). The

seaward limit was taken as the downstream extent of most estuarine sediments visible on aerial photographs. The base flood elevation as determined by FEMA ranges from approximately 12 feet (NAVD88) near Bellingham Bay and Lummi Bay to approximately 25 feet (NAVD88) at the junction of the Lummi and Nooksack Rivers, a distance of about 4.6 miles.

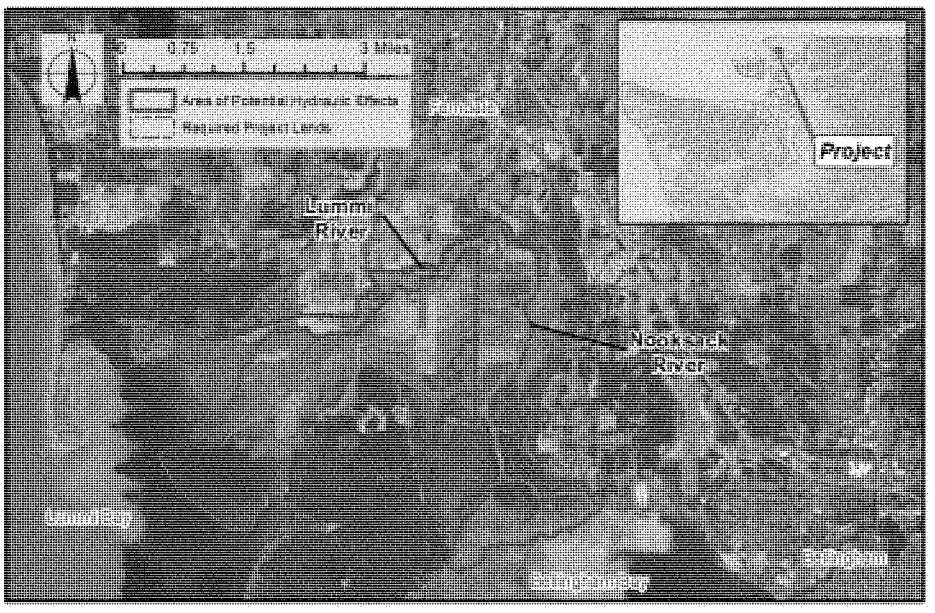

Figure 2-2-2. Nooksack River Delta: Area of potential hydraulic effects

The Ecosystem Output Model (EOM), described in Appendix G utilized an area of restored process determined as follows:

The upland portion of each analysis area was delineated to ensure that the area included all stressor distributions within defined buffer distances from the shoreline. In the aquatic areas, the shape of the Analysis Area was determined by a combination of:

- The GIS area provided initially by the design team and the associated parcel map for the proposed action
- Ensuring an area encompassed all delineated tidal wetlands
- For any Analysis Area that extended through an aquatic area, boundaries were established approximately perpendicular to the shoreline orientation where the upland meets the shoreline.

The area of restored process at Duckabush is shown in Figure 2-2-3 as 1807 acres. For more information, please refer to Puget Sound Nearshore Ecosystem Restoration Project Fish and Wildlife Coordination Act Section 2(b) report in Appendix J, Environmental Compliance Documentation.

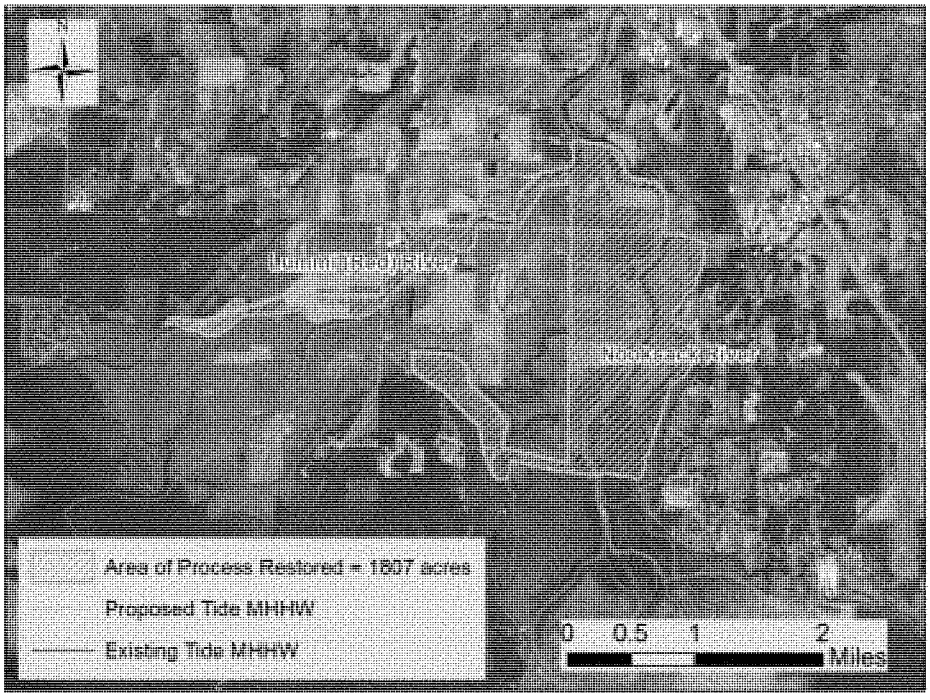

Figure 2-2-3. Area of process restored used in ecosystem output model at the Nooksack River Delta.

The Nooksack River Delta has three leveed areas listed in the National Levee Database (shown in Figure 2-2-4):

- The Ferndale/Nooksack levee system consisting of Rainbow Slough, Rayhorst, Sigardson, Ferndale Water Treatment Plant and Ferndale levees along with high ground, Haxton Way and the North Red River Road provide flood risk reduction to the largest area.
- The Red River Levee provides flood risk management to the Lummi Delta and is entirely on Lummi Tribal Lands.
- The Hovander Park and Dean Foods levee areas are located on the left bank of the Nooksack River. The Dean Foods levee is no longer maintained and has been abandoned as a levee. The land behind and including the Hovander-Dean Foods levees up to high ground has been purchased as a conservation easement by the Washington Department of Fish and Wildlife.

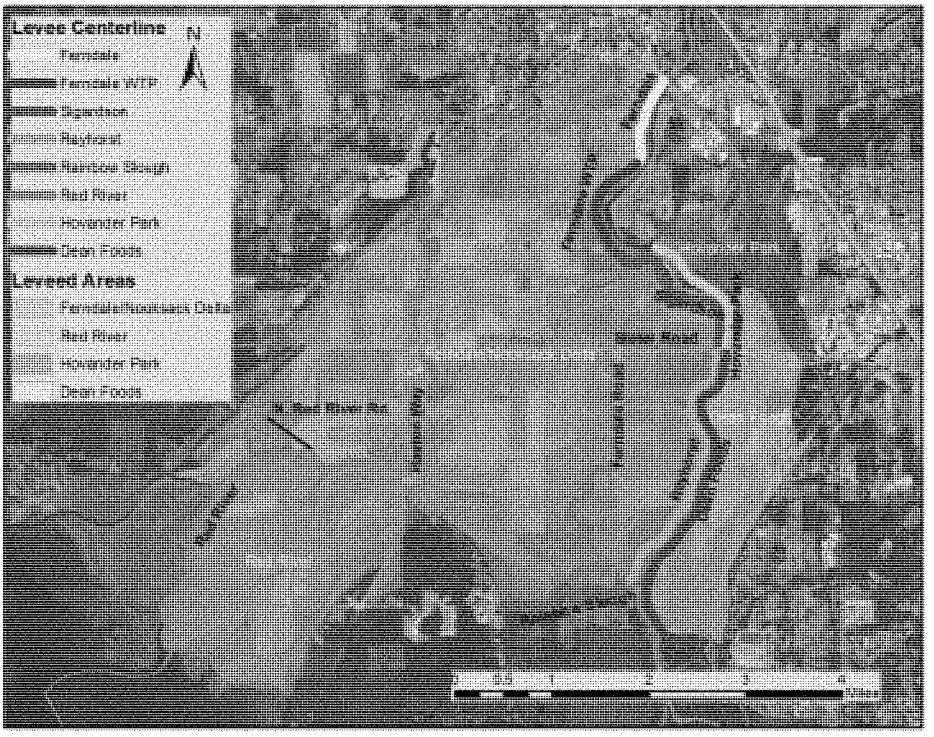

Figure 2-2-4. Leveed Areas in the Nooksack River Delta (Source: National Levee Database)

Table 2- 2-1 summarizes the levees in the Nooksack Delta. The level of protection is given, where available, as the Annual Exceedance Probability (AEP) for the overtopping flow. The Levee Screening Action Classification (LSAC) for all right bank levees in the Nooksack Delta is "4" or "low risk warranting priority actions to reduce risk."

Table 2- 2-1. Levee details for Nooksack Delta. (Sources: Corps Levee Screening, Whatcom County)

Levee System	Levee Name	LSAC	PL 84-99	Residual Risk AEP (USACE)	Residual Risk AEP (Whatcom Co.)	% Area Inundated > 2 ft
Ferndale/Nooksack Delta						
	Rainbow Slough	4	Y	10%	<1%	82%
	Rayhorst	4	Y	10%	10% - 20%	83%
	Sigardson	4	Y	10%	2% - 4%	94%
	Ferndale WTP	4	Y	20%	<1%	99%
	Ferndale	4	Y	20%	4% - 10%	98%
	Red River Road	NA	N	≥ 20%††	NA	NA
Red River						
	Red River	4	Y	20%	NA	100%
Hovander/Dean Foods						
	Hovander Park	NA	Y	10%	> 20%	100%
	Dean Foods	NA	N	NA	> 20%	NA

†† Assumption is the same or less than Red River Levee which was built at the same time.

NA = Not Applicable.

2-2.1 Functional Design Requirements

This section describes the hydrologic and hydraulic setting for the site and the intended hydraulic consequences of the design features.

2-2.1.1 Consequences of flows exceeding discharge capacity of the project

The purpose of this site is to restore aspects of natural tidal flow and sediment transport to the Nooksack and Lummi Estuaries, allowing the reestablishment of portions of a distributary channel system. Water control structures include setback levees and an engineered diversion structure controlling flow at the junction of the Nooksack and Lummi Rivers. These structures will be designed to convey discharges equivalent to the current capacities of the existing levees. Flows in excess of these discharges may result in local flooding of areas adjacent to and downstream of these structures. These consequences will be assessed during Project Engineering and Design (PED).

2-2.1.2 Project-induced changes obligating mitigation

No compensatory mitigation is included for this site as none is required. Implementation of restoration at this site would involve only minor construction activities in the aquatic environment. The restoration actions 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 based on the specific effects of the project.

2-2.1.3 Discharge-frequency relationships

Predictions for river discharge-frequency relationships are available from multiple sources. A Flood Frequency Analysis (FFA) prepared by WEST Consultants Inc. for USACE in 2011 gives the most conservative estimates. This source has the longest period of record. This study used U.S. Geological Survey (USGS) gage readings taken from the Nooksack River at Ferndale (USGS 12213100) between 1945 and 2010. The Ferndale gage is about 1.5 miles upstream of the head of the Lummi River. Estimates are shown in Table 2-2-2. Also included are discharge-frequency estimates from a 2004 FEMA Flood Insurance Study for Whatcom County (53073CV000A). Discharges from this study are adjusted for overflow losses at Everson. Overbank losses to the Sumas River, to the north, are significant for events greater than 10 years (FEMA 2007). Another study by Franz (2005) looked more closely at the overbank losses. The two studies that consider losses to the Sumas River predicted lower discharges than the traditional Flood Frequency Analysis. For the purposes of analysis, the higher estimates from the USACE Flood Frequency Analysis study are included as a conservative assumption. The hydrology for the Nooksack River Delta will be reviewed in PED.

Table 2-2-2. Peak Discharge-Frequency predictions for the Nooksack River near Ferndale

Method	10% AEP (cfs)	2% AEP (cfs)	1% AEP (cfs)	0.2% AEP (cfs)
USACE FFA 2011	41,100	58,600	67,200	90,600
FEMA FIS, Whatcom Co. 2007	40,000	48,500	51,000	-
Franz 2005 Study	39,600	56,700	60,500	70,000

2-2.1.4 0.2% Annual Exceedance Probability (500-year return interval) flood

The area of potential hydraulic effect for the Nooksack Estuary is dominated in the lower reaches by storm surge from Lummi Bay and Bellingham Bay, and in the upper reaches by fluvial flows. Table 2-2-3 summarizes the 0.2% AEP hydraulic conditions for the site area. Since work at this site involves the construction or modification of several bridges on major roadways (Ferndale Road, Imhoff Road, Slater Road [2 bridges], Hillaire Road, and Haxton Way), the 0.2% AEP coastal base flood elevations from Lummi and Bellingham Bays will need to be evaluated during PED.

Table 2-2-3. 0.2% AEP hydraulic conditions for the Nooksack Estuary

Flooding source	Elevation (feet, NAVD88)	Discharge (cfs)
Strait of Georgia (BFE)	TBD	-
Bellingham Bay (BFE)	TBD	-
Nooksack River	-	90,600

2-2.1.5 Stage-discharge relationships

Current stage–discharge relationships as reported in Table 2-2-4 are from the FEMA Flood Insurance Study (FEMA 2007) and are based on modeling conducted in 1991. Stage locations are at the Slater Road Bridge and the head of the Lummi River. In order to forecast the new stage-discharge relationsbips, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of the estuary including the effects of possible future sedimentation. In certain locations, such as at the flow diversion, a 3-D model or physical model may be required. This will be addressed during PED.

Whatcom County, as part of their Comprehensive Flood Hazard Mitigation Planning (CFHMP) has developed a 1-D unsteady hydrodynamic model for the Lower Nooksack River using the FEQ (Full Equations) model. This model has also been used to examine several restoration options for the lower Nooksack River floodplain using the hydrology developed by Franz (2005). It is difficult to compare the Whatcom County FEQ and FEMA models as they are based on different assumptions for watershed hydrology.

Updated inundation modeling will be conducted in PED using a 2-D hydrodynamic model such as HECRAS to compare with and without project conditions including the effects of possible future sedimentation. hydraulic modeling during PED is being used both to fine tune the design of the levee setbacks, to provide a level of flood risk management equal to the existing level and to ensure that project features are designed to achieve and to continue to achieve the desired ecosystem benefits with minimal maintenance.

Table 2-2-4 Stage discharge relations as shown in 2007 FEMA Flood Insurance Study for the Nooksack River. Elevations have been converted from NGVD29 to NAVD88 using an offset of 3.9 feet.

Location	10% AEP Stage (feet NAVD88)	1% AEP Stage (feet NAVD88)	0.2% AEP Stage (feet NAVD88)
Slater Road Bridge near river mile 3.3	20.8	21.1	21.4
Head of Lummi River near river mile 4.6	25.2	25.8	26.4

2-2.1.6 Flow duration

Flow duration data are available from daily discharge readings near Ferndale (USGS 12213100) for the period between October 1966 and the present. An unsteady flow analysis or flood flow routing will likely be required for this site and will be part of the 2-D hydrodynamic modeling conducted in PED.

2-2.1.7 Flood inundation boundaries and flood stage hydrographs

The current flood inundation boundaries as reported for the 100-year flood event in the Whatcom County FEMA Flood Insurance Study are shown in Figure 2-2-5. For clarity, forecast 1% AEP flood elevations have been noted on the FEMA map at the flow split of the Lummi and Nooksack River and at the downstream project limits. In order to forecast the new flood inundation boundaries, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of the estuary including the effects of possible future sedimentation. The 2-D modeling is in support of design of the levee setbacks and to ensure that project features are designed to achieve and to continue to achieve the desired ecosystem benefits with minimal maintenance. A 3-D model or possibly a physical model may be required to assess the hydraulics of the diversion structure for design purposes. It will be used only if this structure is retained as a site feature and site conditions and operational considerations require it. This will be addressed during PED.

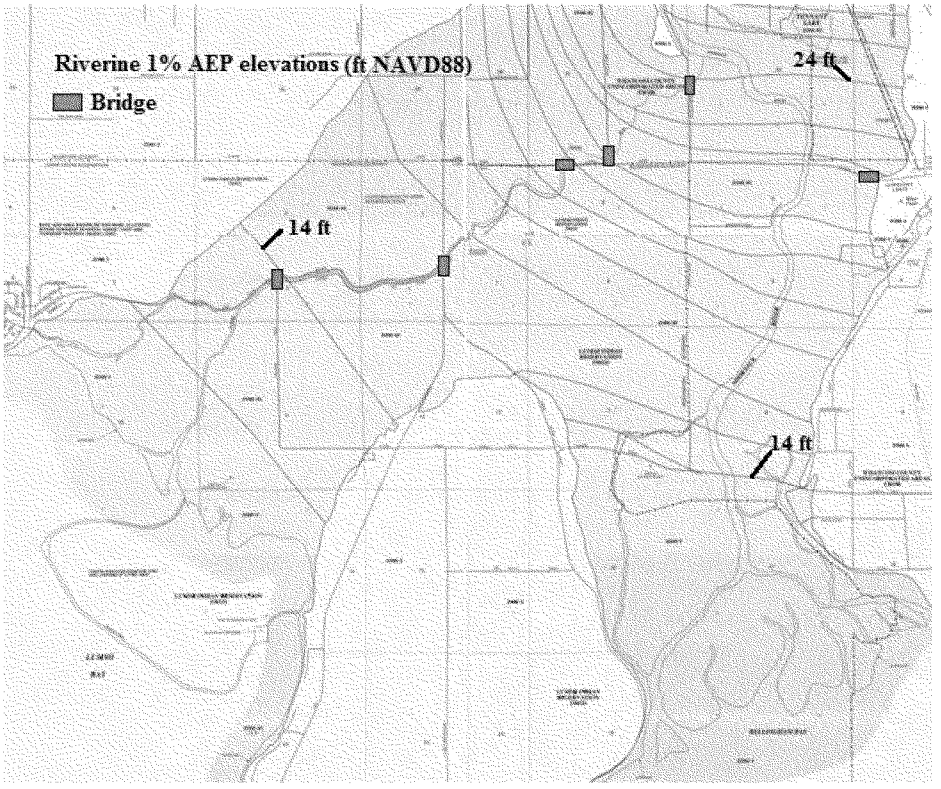

Figure 2-2-5. FEMA 1% AEP flood zone from Flood Insurance Rate Map. Aggregated from map numbers 53073C-1160D, -1170D, -1180D, and -1190D (FEMA 2004). Note: Maps are based on 1991 modeling.

2-2.1.8 Reservoir yields

No reservoirs are planned as part of this site. (Not applicable.)

2-2.1.9 Risk and uncertainty analysis for sizing of the project under study

Channel sizing

Given the complexity of this restoration, none of the empirical channel sizing equations are appropriate for the channel sizing design. A 2-D hydrodynamic model should be used to determine the appropriate channel sizing and configuration. In certain locations, a 3-D model may be appropriate. This will be addressed during PED.

Sea Level Change

The Nooksack River Delta is located in the San Juan Islands – Georgia Strait Sub-basin of Puget Sound. Sea level change calculations for the San Juan Islands – Georgia Strait Sub-basin are based on the Friday Harbor tide gage and are calculated using the guidance in ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, and ETL-1100-2-1, Procedures to Evaluate Sea Level Change: Impacts,

Responses and Adaptation (USACE 2013, 2014). Table 2-2-5 shows the range of sea level change projections for the 50-year project life as well as the 100-year horizon assuming a project start date in 2020. Changes are referenced to 1992, which is the midpoint of the most recent National Tidal Datum Epoch as established by NOAA. The high rate calculations indicate a sea level rise of 2.2 feet in 50 years after project start and a rise of 6.2 feet after 100 years.

The largest risk associated with sea level change at this site is the displacement of habitat upstream, with vegetated marshes becoming intertidal habitat and intertidal habitat becoming sub-tidal habitat. Tidal marshes can adapt to sea level change by building elevation to keep pace with the rising water levels, but this requires an adequate supply of sediment and/or organic matter accumulation. Future studies should include a sedimentation analysis to determine what impact the restoration will have on sedimentation rates and if there is sufficient sediment accumulation to keep pace with the projected sea level change.

Table 2-2-5. Projected Sea Level Change (feet) Friday Harbor (Gage 9449880). Source: USACE Sea-Level Change Curve Calculator (2015.46).

Year	Low (feet)	Intermediate (feet)	High (feet)
1992	0	0	0
1995	0.01	0.01	0.01
2000	0.03	0.04	0.05
2010	0.07	0.1	0.19
2020	0.1	0.17	0.39
2030	0.14	0.27	0.68
2040	0.18	0.38	1.03
2050	0.22	0.51	1.46
2060	0.25	0.66	1.97
2070	0.29	0.83	2.55
2080	0.33	1.01	3.2
2090	0.36	1.22	3.92
2100	0.4	1.44	4.72
2110	0.44	1.68	5.6
2120	0.48	1.93	6.55

For levees, the project is designed to meet the current level of residual risk which, at Nooksack, varies from 20% AEP to 2% AEP depending on the levee. Since the project is not for flood control, future adaptation of levees for sea level change is not within the project authority. The levee system at the Lummi River Delta includes long segments of coastal dikes which would be affected by sea level change well before the majority of the setback levees in the project. It is assumed that adaptation of the levee system to sea level change would be undertaken either by the Lummi Nation, individual diking districts or under a separate authority. Elements of the levee design that will be finalized in PED will include robustness considerations such as shallow side slopes and wide crest-widths. Some of these features may be usable by others to adapt to future sea level change. The Lummi River setback levees, as currently estimated, range in crest elevation from 15 to 20 feet NAVD88. This implies that the most seaward extents of the levees will begin to be overtopped by the base coastal flood by 2078 (about 50 years after construction) for the high rate of rise assumption and by 2155 (about 130 years after construction) for the intermediate level of rise. The Nooksack River setback levee, as currently estimated, ranges in crest elevation from 20 to 24 feet NAVD88. The base coastal flood elevation will begin to exceed the most

seaward extents of the levee by 2135 (about 105 years after construction) for the high rate of rise assumption and by 2270 (about 240 years after construction) for the intermediate level of rise. However, since the levee is primarily governed by river flooding, overtopping events will likely occur sooner than those times, as river flows encounter a higher coastal backwater condition. Levee performance and expected effects of sea level change will be reassessed in PED once hydraulic modeling is completed and levee crest elevations have been refined.

For bridges, one bridge replacement in the Nooksack Site (Hillaire Road) would be affected by the 100-year intermediate level of rise of 1.7 feet. This level of rise puts the coastal base flood elevation (BFE) at the Hillaire Road Bridge at approximately the same elevation as the current FEMA forecast 1% AEP riverine flood level. As a result, an intermediate rate of sea level change assumption will not significantly affect the bridge design. For 100-year high assumption, Haxton Way and Hillaire Road Bridges would be affected. Bridges designed with the 100-year intermediate SLC assumption would incur higher maintenance costs as the 3 foot debris clearance below the bridge would no longer be available and water surface could inundate the lower foot of the bridge superstructure. Bridge design during PED should confirm that the bridges will be able to withstand debris impacts and up to one foot of girder inundation. These conditions are summarized in Table 2-2-6.

Table 2-2-6. Controlling water surface in design of bridges at the Nooksack site.

SLC Condition	Elevation of coastal BFE (NAVD88)	Bridge clearance criterion
Current BFE	12.2 ft (Nooksack R.) 12.5 ft (Lummi R.)	All 6 bridges governed by riverine flooding
BFE + 100-year Low SLC	12.9 ft	All 6 bridges governed by riverine flooding
BFE + 100 year Intermediate SLC	14.2 ft	Hillaire Road Bridge marginally governed by coastal BFE (14.2 ft vs 14 ft)
BFE + 100 year High SLC	18.3 ft	Haxton way and Hillaire Road Bridges governed by coastal BFE

Figure 2-2-6 shows the land elevations that fall within the three sea level changes assumptions for coastal BFE. Each color indicates the additional area inundated from Lummi or Bellingham Bay for each successively higher SLC assumption. The elevations shown in the figure are based on 2011 Lidar from the Puget Sound Lidar Consortium (PSLC 2011) and indicate land elevation only. Figure 2-2-6 is not an inundation map. It does not show the influence of riverine inundation or the effects of roadways, flow control structures or levees.

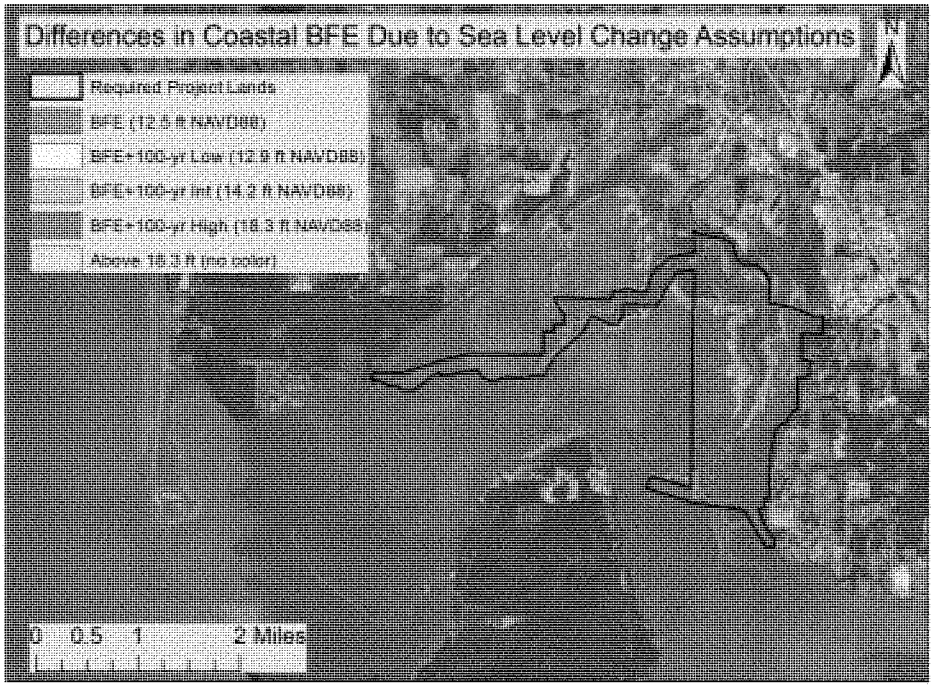

Figure 2-2-6. Land at or below coastal BFE elevation for present day and projected 100-year low, intermediate and high rates of sea level change.

USACE hydraulic analysis has not been carried out for this site and the riverine BFE has not been established for the three rate of rise assumptions. Most of the land in the Nooksack River delta lies below the Coastal BFE elevation with the exception of the Lummi peninsula and areas adjacent to existing levees.

Figure 2-2-7 shows the land elevations that fall within the three sea level changes assumptions for Mean Higher High Water (MHHW). Figure 2-2-7 is not an inundation map, since USACE hydraulic analysis has not been carried out for this site. The elevations shown in the figure are based on 2011 Lidar from the Puget Sound Lidar Consortium (PSLC 2011) and indicate land elevation only – not the effects of levees. The land on the east side of the Nooksack River delta lies above current MHHW level, while the land on the west side of the delta is mostly below the current MHHW elevation. This map supports the assumption from Section 2-4.1.11 that land subsidence has likely occurred in the diked agricultural lands, as the highest elevations are immediately adjacent to the levees. Properties in the delta do not flood under high tide conditions because of the system of coastal dikes and riverine levees that line the delta. Under the largest sea level change assumption (100-year high), MHHW would extend inland along the banks of the Lummi River channel as well as inland along the banks of the Nooksack River Channel.

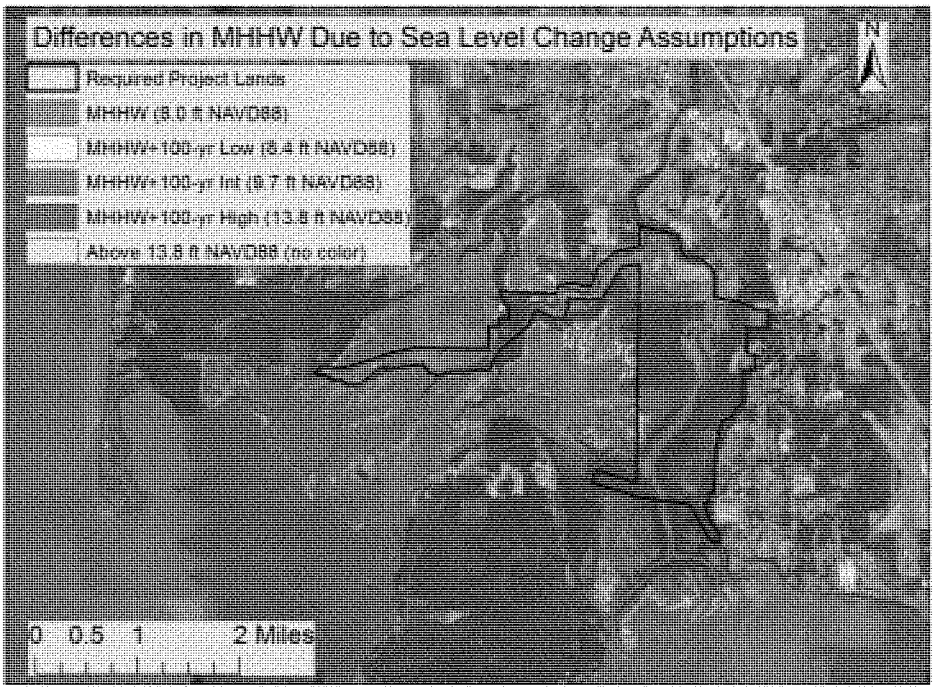

Figure 2-2-7. Land at or below MHHW for present day and projected 100 year low, intermediate and high rates of sea level change.

Climate Change

ECB No. 2014-10 (USACE 2014) provides initial guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate change adaptation policy. There is a strong consensus among recent studies that future storm events in the Pacific Northwest region will be more intense and more frequent compared to the recent past (USACE 2015). The overall projected trends for the Pacific Northwest are summarized in the FR/EIS section 3.6.5.1.

Streamflow in the Nooksack River responds to local climate variations and typically has higher precipitation-driven flows in the fall and early winter with a secondary peak from spring snowmelt. Using 3 climate scenarios downscaled from Global Climate Models (GCMs) and the Distributed-Hydrology-Soil-Vegetation model Dickerson-Lange and Mitchell (2014) modeled the potential impacts of climate change on Nooksack River hydrology. Simulations of future streamflow in the Nooksack River project increases in median winter discharge ranging from34% to 60% by the year 2050. Projected decreases in summer flows are on the order of 20% to 30%. Additionally the spring melt peak is forecast to shift from June to May by 2050 eventually leading to a one-peak annual hydrograph for the Nooksack more typical of rain dominated basins.

Dickerson-Lange and Mitchell conclude:

> "With a growing area contributing to runoff and less snow to attenuate winter rain as temperatures warm, the frequency and magnitude of Nooksack River floods will likely increase. Currently, the flood risk declines later in the winter season because the area contributing to runoff shrinks and the snowpack reaches a threshold thickness for attenuating rainfall. Due to future warming, the basin will have a reduced snowpack for a longer period of time; our results support

a shift from November into December or January as the dominant time period for flood risk. Our results also show an increase in annual flood peak magnitudes due to larger precipitation extremes projected by the GCMs in the winter months".

As an example, one of the conclusions from the study is that a 10% AEP flood discharge may have an AEP of 33% by 2050. While the Nooksack River is projected to exhibit similar trends to other Western Washington Rivers, the Nooksack is anticipated to change more quickly and to a greater extent than rivers in the southern part of Western Washington. Of particular concern is the loss of glacier melt contribution to streamflow during the low flow season, with projected decreases in snowpack from 36% -71% below elevations of 1000 m, 25-63% at 1000 – 2000 m and 15%-54% above 2,000 m (Grah and Beaulieu 2013).

Higher winter flows, especially flood discharges, could result in an increase in sediment transport. The Nooksack River carries an annual sediment discharge of about 1,400,000 tons per year at a mean annual discharge of 3,200 cfs (Czuba 2011). Compared with the other main contributor of sediment in Puget Sound, this is half the sediment discharge but 1/6 of the flow. Should climate change result in higher winter discharges becoming more common, the sediment yield may increase accordingly. Conversely lower summer flows may slow the movement of sediment out of the river system. The potential impacts to river deposition are difficult to estimate. That will depend on the future balance between sediment transport potential and the available sediment supply. The sedimentation analysis conducted during PED will provide an indication of whether more frequent high flow events will trend towards higher rates of sedimentation at the Nooksack site. The results of the analysis will determine final setback levee elevations, predict future stage-discharge relations, channel slope and inundation limits as well as assess the environmental effects of changes in sedimentation and the requirements for operations and maintenance.

2-2.1.10 Water quality conditions

No water quality information has been reviewed for this site. The anticipated water quality effects are as follows:

- Construction-related turbidity and suspension of sediments may occur due to fill removal, construction of new embankments, installation of water control structures, filling of ditches, and excavation of new channels.
- Temporary increases in sedimentation may occur in Lummi Bay because of the release of sediment currently impounded upstream and because of the evolution of the distributary channel system. The work at this site proposes to increase sedimentation in the Nooksack Estuary downstream of the junction with the Lummi River, which may also affect water quality. These effects, together with other sedimentation issues, should be evaluated during PED.
- The quality of water from the Nooksack River watershed presents a significant design consideration. Fecal coliform bacteria loading from the Nooksack River adversely impacted Portage Bay to the point that shellfish harvesting was halted over the 1996 to 2006 period. Recent trends in fecal coliform densities may argue against sending additional water into the Lummi River and Lummi Bay, due to the resultant potential closure of Lummi Bay shellfish beds to ceremonial, subsistence, and commercial harvest.

2-2.1.11 Groundwater conditions

No groundwater information has been reviewed for this site. The restoration proposes to alter both flood-related and non-flood-related hydraulic grade lines of flows in both the Lummi and Nooksack Rivers, which may have consequences for groundwater. The extent of freshwater seepage into the estuary and the character of aquifers in the area have not been assessed. Many of the properties in the estuary area are most likely on septic systems. A review of the potential effects on water wells, septic systems, and groundwater seepage will be carried out during PED.

The planned work at this site will allow an increased tidal prism upstream of current limits, which can be accompanied by saltwater intrusion into the hyporheic zone. Since the goal is to restore the historic function of the estuary, restoration of historic salinity patterns is presumed to be a desirable outcome.

2-2.1.12 Preliminary project regulation plan

The primary water control structure at this site is the engineered diversion structure at the junction of the Lummi and Nooksack Rivers.

According to USACE design drawings from 1950, a diversion structure installed at that time consisted of a V-shaped weir/orifice installed within the levee between the Nooksack River and the Lummi River. The weir/orifice was accessed by an open channel leading from the Nooksack River and included baffle blocks for energy dissipation on the downstream (Lummi River) side. Due to excessive sedimentation in the inflow channel, it appears that, some time later, this diversion was retrofitted with an 80 foot long culvert pipe leading from the Nooksack River to the Lummi River. The pipe inlet is perched above the Nooksack River water surface until flows reach about 9600 cfs. In addition, the pipe had been damaged and is partially collapsed, severely limiting the amount of water that can pass at flows above 9600 cfs. The flow requirements for the Lummi River for salmonid use are about 200 cfs, with the possibility for somewhat lower flows during the fall months (USACE 2000).

No significant details have been developed for the new flow diversion structure. Since one of the requirements for the engineered diversion structure is that it will limit flows into the Lummi River to 200 cfs, this will be either an underflow structure, a structure with a controlled crest height or possibly a controllable culvert. The structure design, as well as a regulation plan, if necessary, will be addressed during PED. The remaining water control structures at this site are passive (levee setbacks, culverts).

2-2.1.13 Preliminary Real Estate taking line elevations

The current real estate limits are delineated by the construction area, staging areas, and access roads and do not include the entire potential area of hydraulic effects. Real estate assumptions, valuations, and planning documents have been appropriately scaled for the current level of design.

In the case of the removal or modification of flow controls such as levees, roads, bridge opeuings, and culverts, the restoration will likely cause a reduction in backwater effects during high river flows, thus altering current flood patterns. These changes will also allow the tidal prism to travel further upstream, increasing tidal effects. In order to forecast the hydraulic effects of the site and to refine the real estate taking line elevations, a 2-D hydraulic model will have to be implemented that reflects the proposed geometry of the completed work. In certain locations, such as at the flow diversion, a 3-D model or physical model may be required. This will be addressed during PED.

As additional surveys, modeling, and design are completed during the PED phase, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Final Feasibility Report/Environmental Impact Statement (FR/EIS), Appendix C, *Real Estate Plan.*

2-2.1.14 Criteria for facility/utility relocations

The hydraulic impacts from relocation of utilities have not been evaluated for this site. Bridge replacements, road abandonment and relocation, and channel alterations will likely all require the relocation of utilities. In addition, the construction of the engineered diversion structure at the junction of the Nooksack and Lummi Rivers may also require the routing of utilities to the new facility. Criteria for these activities will be evaluated during PED.

2-2.1.15 Criteria for identification of flowage easements required for project function

As discussed in Section 2-2.1.13, the planned work at the Nooksack River Delta will alter both the flooding patteru from river flows and the tidal elevations in the Nooksack River and Lummi River estuaries. Although these effects are not anticipated to affect the site function, there may be some net changes in flowage easements. In addition, the planned levee setbacks and the removal and setback of the North Red River Road may also require changes in flowage easements. In order to identify the flowage easements, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of the levees and roadways including potential future sedimentation. In certain locations, a 3-D model or physical model may be required. This will be addressed during PED.

2-2.1.16 Criteria in support of project OMRR&R requirements

Monitoring needs associated with the hydraulic function of the site include the following:

- Water control structures such as the engineered diversion structure at the junction of the Lummi and Nooksack Rivers require monitoring and maintenance to ensure that they are operating as designed. Operation of the engineered diversion structure is discussed in Section 2-2.1.12 and will be addressed during PED.
- Roadway embankments and slope protection on levee setbacks should be monitored for signs of instability or scour at an interval to be determined during PED.
- Bridge abutments and piers will require periodic inspection to ensure that channel migration is not affecting them and that any scour or slope protection is functioning as designed.
- Project areas in the Nooksack estuary will require periodic monitoring to observe whether excessive erosion or sedimentation is occurring that affects either habitat or properties.
- Salinity and pollutant monitoring in the estuary should be carried out to confirm no significant impacts to water quality.

2-2.1.17 Environmental engineering considerations

In the context of hydrology and hydraulics, environmental engineering is taken to mean water supply and sanitation.

Water Supply

Numerous water supply lines are assumed to exist throughout the entire site. Rerouting of water lines will need to be coordinated with local landowners and utilities. Location, depth and possible groundwater impacts to any wells in the area of potential hydraulic effect will be reviewed during PED.

Sanitation

The properties in the site area are assumed to be on septic systems. The extent to which changes in tidal prism will affect leach fields and groundwater flow will be addressed during PED.

2-2.2 Residual Flooding Consequences – With Project Flooding

This section discusses the predicted hydraulic conditions after construction of the proposed restoration.

2-2.2.1 Warning time of impending inundation

The closest USGS gage for this part of the watershed is at Ferndale (USGS 12213100), approximately 1.5 miles upstream from the upstream end of the site at the junction of the Lummi and Nooksack Rivers. Aside from regional warnings for possible flooding, no new warning system is planned.

2-2.2.2 Rate of rise, duration, depth, and velocity of inundation

In order to forecast the with-project depths and velocity of inundation, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of work at the site. This will be addressed during PED. In certain locations, a 3-D model will likely be required. Since the area is quite large, flood routing may be a factor in the rate of rise and flow duration at various locations in the site. Therefore, an unsteady flow analysis or flood flow routing may be required.

2-2.2.3 Historic, 1% and 0.2% exceedance (100-year and 500-year) flood extents

In the past, the Lummi and Nooksack Rivers have occupied channels spanning the entire estuary, transporting sediment and creating the current floodplain. In order to forecast the with-project 100-year and 500-year flood inundation boundaries, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of work at the site. This will be addressed during PED. See Section 2-2.1.7 for the current 1% (100-year) predicted flood extents.

2-2.2.4 Access and egress problems created by flooding

The restoration will raise the height of many of the roadways and bridges in the area as well as the height of the roads on setback levees. This will increase the reliability of access and egress from the area during floods. Other bridge approaches may be designed to allow for overtopping, so that access may be not be available to those structures during high water events. The selection of reliable routes for flood access/egress will occur during PED and will determine which bridges and roadways are required for emergency access/egress.

2-2.2.5 Potential for loss of life as a result of 10-2.2.1 through 10-2.2.3

The potential for loss of life as a result of the proposed restoration is low and does not represent a substantial change from the current conditions.

2-2.2.6 Identification of any potential loss of public services

The potential for loss of public services as a result of the proposed restoration is low. Since the restoration will raise bridge elevations and roadways, this will reduce the possibility of access issues and utility disruption during floods. Some reduced access to areas of the Lummi River Estuary may occur.

2-2.2.7 Potential physical damages

Potential physical damages that can occur during flooding will be addressed by the hydraulic analyses conducted during PED. This will include impacts due to flooding for property owners in the site vicinity. It will also include an evaluation of the need for scour protection on bridge abutments and piers as well as roadway embankments and levees and it will address the issues of channel stability and sediment outflow from the estuary. Potential physical damages to the water control structures that are planned for the site will be assessed as well.

2-2.3 Project Induced Flooding – Change from Pre-Project Conditions

This section describes the effects of the proposed restoration on flood elevations, flood patterns, and flood frequency.

2-2.3.1 Information categories required by 2-2.2

Flooding in the Nooksack River Delta is controlled by riverine flows in the upper areas and by tides and storm surge in the lower estuary. The proposed work at this site will change the pattern of flooding in the site vicinity and may also change the frequency of flooding in some areas for some high occurrence (low return interval) flood events. Work at the site is not anticipated to appreciably change the 100-year flood limits. In order to forecast the new flood inundation boundaries, a 2-D hydraulic model will have to be implemented that reflects the proposed geometry of the estuary. In certain locations, a 3-D model may be required. This will be addressed during PED.

2-2.3.2 Anticipated frequency of induced flooding

Due to the planned changes in hydraulic grade lines, the proposed work at this site may change the frequency of flooding in some areas for some high occurrence (low return interval) flood events. The restoration is not anticipated to affect the 100-year or 500-year return interval flooding. In order to forecast the changes in flood frequency for different locations, a 2-D hydraulic model will have to be implemented that reflects the proposed geometry of the estuary. In certain locations, a 3-D model may be required. This will be addressed during PED.

2-2.4 Inundation Risk 0.2% Exceedance (500-year Return Interval) Flood

The proposed work at the site is not anticipated to appreciably change the 500-year flood limits. In order to forecast the 500-year flood inundation boundaries, a 2-D hydraulic model will have to be implemented that reflects the proposed geometry of the estuary. In certain locations, a 3-D model may be required. The

principal risk for the 500-year flood in the lower areas of the estuary is due to sea level rise (refer to Section 2-2.1.9).

2-2.5 Hydraulic Studies

This section discusses the hydraulic studies, construction considerations, and instrumentation and monitoring needs for the site. The anticipated hydraulic studies at this site are summarized in Section 2-21.

2-2.5.1 Hydraulic roughness determinations

The FEMA Flood Insurance Study lists typical Manning hydraulic roughness values for Whatcom County hydraulic analyses as 0.040 for natural channels, 0.070 for overbanks with dense brush, and 0.100 for overbank areas with trees. Roughness values will be reviewed during PED using engineering judgment, aerial photographs of the site area and, if necessary, fieldwork.

2-2.5.2 Water surface profiles

Current water surface profiles as reported in the FEMA Flood Insurance Study will need to be revised to reflect the proposed changes in the floodplain. In order to forecast the new water surface profiles, a 2-D hydraulic model will have to be implemented which reflects the proposed geometry of the estuary and the planned design and operations of the engineered diversion structure. The effects of storm surge and wind waves will need to be incorporated into the analysis of water surface levels. In certain locations, a 3-D model may be required. The predicted water surface profiles depend on the completion of design and operation plans for the flow control structure at the junction of the Lummi and Nooksack Rivers, which may require both numerical aud physical modeling. This will be addressed during PED.

2-2.5.3 Stage-discharge relationships

In order to forecast the new stage-discharge relationships at flow control structures and bridges, a 2-D hydraulic model will have to be implemented that reflects the proposed geometry of the estuary and the planned design and operations of the engineered diversion structure. In certain locations, a 3-D model may be required. The flow control structure at the junction of the Lummi and Nooksack Rivers may require both numerical and physical modeling. This will be addressed during PED.

2-2.5.4 Head loss

The predicted head losses depend on the completion of design and operation plans for the flow control structure at the junction of the Lummi and Nooksack Rivers. Design of this structure may require both numerical and physical modeling. This will be addressed duriug PED.

2-2.5.5 Flow and velocity

Flow and velocity information from the hydraulic analyses will be used to assess the possibility for sediment transport, scour, and bank erosion in the site area.

2-2.5.6 Structural sizing needed to meet design capacity including slope protection

Siziug of the flow control structure at the junction of the Lummi and Nooksack Rivers may require both numerical and physical modeling. The hydraulic analysis conducted during PED will include the need for slope protection on levees, roadway embankments, and bridge abutments and will address the issue of scour at bridge pilings. Additionally, the need for scour protection from effects of waves and storm surge levee will also be evaluated. Several large woody debris installations are included in the plans for this site. These will need to be designed for size, composition, and stability as part of PED.

2-2.5.7 Water control facilities

The water control facilities planned at this site include levees, culverts, large wood jams, and an eugiueered diversion structure. Specific designs are not yet formulated for these structures. Design of all these features will be addressed during PED. The flow control structure at the junction of the Lummi and

Nooksack Rivers will require numerical modeling and physical modeling if needed, to complete design and operation plans. The modeling will evaluate the design of the facility and its potential effects on hydraulics and sedimentation as well as determine the need for an energy dissipation facility in conjunction with conveying flow from the Nooksack River to the Lummi River.

2-2.5.8 Energy dissipating facilities

Depending on the design of the diversion structure, an energy dissipation facility or stilling basin may be needed as part of conveying flow from the Nooksack River to the Lummi River. The need for such a structure, its design, and its potential effects on hydraulics and sedimentation will be evaluated during PED.

2-2.5.9 Erosion control requirements

Construction

The planned earthwork for this site does not specify dredging or water-based equipment. Since bridge supports, slope protection, roadway, bank fill material, culverts, and in-channel sediments will be removed, appropriate in-water sediment control measures will need to be used during construction. Any in-water or overwater construction should follow accepted best management practices for both erosion and contaminant control.

With Project

The hydraulic analysis conducted during PED will include the need for erosion control or scour protection on levees, roadway embankments, bridge foundations, and water control structures. No erosion control is anticipated outside of the construction boundaries since the goal is to reestablish natural erosion and sedimentation processes. New and existing slope protection should be monitored for signs of erosion at an interval to be determined during PED.

2-2.5.10 Existing and post-project sedimentation

The planned levee setbacks and the removal of flow obstructions in both parts of the Nooksack and Lummi River Estuary will allow the mobilization of sediments that have been impounded upstream and at the channel margins. Shoreline properties and habitat in and downdrift of the Lummi River Estuary will likely experience some temporary increases in sedimentation as these sediments are transported offshore. Areas in the lower part of the Nooksack River Estuary may also experience changes in sedimentation patterns as a result of the planned changes in flow. Restoration of sediment erosion, transport, and accumulation processes are objectives and considered benefits of the project. The amount and potential areas of sedimentation will be evaluated during PED. Monitoring of sedimentation after construction is addressed in the Final FR/EIS, Appendix E, *Monitoring and Adaptive Management*.

2-2.5.11 Water control and order of work during construction

Most channel excavation, embankment removal, and fill removal will be accomplished with land-based heavy construction equipment. Temporary trestle structures and/or local filling may be required along portions of the proposed bridge alignments to provide access for heavy equipment during construction. Large-diameter casing shoring may be required to keep out water and allow access to the top of the drilled bridge pier shafts. A crane will be required to set the girders in place. The temporary trestle or earth fill can then be removed.

Material from the excavated portions of roadway and levees can likely be used for the fill required in the new roadway approaches and setback levees. However, much of the earthwork will be excavation of lowland areas, requiring substantial bucket dredging to form channels. Substantial offhaul and offsite disposal may be required unless beneficial reuse onsite is identified.

If vibratory extraction methods are used to remove pilings, measures should be taken to minimize the loosening of soil and suspension of sediments into the surrounding waterway. In a sensitive estuarine environment, careful excavation and removal of structures may be required.

2-2.5.12 Criteria for facility/utility relocations

See Section 2-2.1.14.

2-2.5.13 Other facilities to meet project goals

Stormwater detention is discussed in Section 2-6.1.1. No other facilities are planned in order to meet restoration goals.

2-2.5.14 Instrumentation and monitoring

A combination of field surveys and aerial photographs will be used to document biological and physical changes to the landscape. Monitoring data can be used to refine adaptive management and corrective measures, as needed. Some of the key monitoring needs and opportunities are summarized in the table in the Final FR/EIS.

2-2.6 Coastal Studies

Coastal base flood elevations were calculated by FEMA as a part of the Whatcom County Flood Insurance Study. The base flood elevations are calculated by combining the effects astronomical tide (caused by gravitational effects of sun and moon), storm surge (rise in water levels as a result of wind stress and low atmospheric pressure), waves breaking onto the shoreline, producing an additional water level rise at the beach (wave setup) and waves running up the beach (wave runup). The 1% annual exceedance coastal base flood elevations are shown on Figure 2-2-3.

It is assumed that the Nooksack Estuary in Lummi Bay is only subjected to wind waves caused by local winds. Measurements at the nearby Bellingham airport (Figure 2-2-8) show that the maximum wind speeds come from the southerly direction and rarely exceed 30 miles per hour. The fetch length in the southwesterly direction is approximately 8 miles, which could result in wave heights up to 5.5 feet with a period of 7 seconds. The impact of wind waves is generally limited to the outer portion of the estuary; however, this area should be designed to withstand this type of wind wave action. Additionally, Lummi Bay may be more exposed to the northerly winds off the Fraser River than Bellingham Bay which is shielded by the peninsula and Lummi Island. It may be appropriate to develop a wind rose for Lummi Bay for the purposes of work at this site. These issues will be addressed during PED. The influence of wind wave activity, storm surge and wave setup will be evaluated during PED. Wave height is not anticipated to be a significant issue for this project as the site footprint is upstream from the estuarine area that is most affected by wave action.

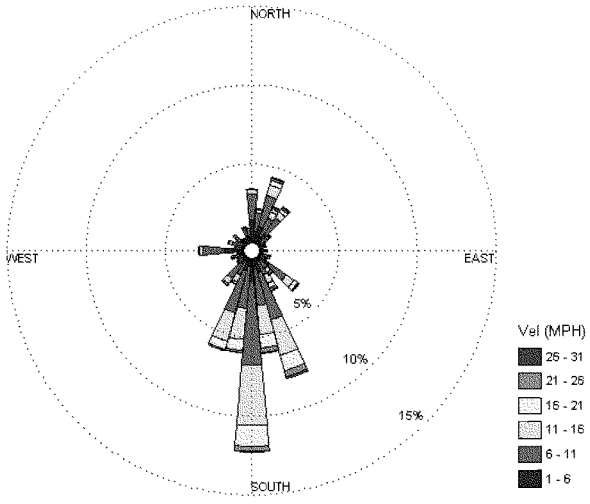

Figure 2-2-8. Wind Rose for Bellingham Airport

Project plans formulated during the conceptual design phase for the Nooksack Delta are based on a Mean Higher High Water tidal datum of 8.03 feet (NAVD88). This datum is from the tide gage at Bellingham (NOAA Gage 9449211). Major tidal datums are summarized in Table 2-2-5. The final design tidal datums will be reviewed and established during PED.

Table 2-2-7. Major tidal datums for Nooksack River Delta, Bellingham (Station 9449211),

Datum Description	Water Level (ft, NAVD88)
FEMA BFE (Coastal)	12.2 – 12.5
FEMA BFE (River)	13-24
Mean Higher-High Water (MHHW)	8.03
Mean High Water (MHW)	7.31
Mean Tide level (MTL)	4.59
Mean Sea Level (MSL)	4.47
National Geodetic Vertical Datum of 1929 (NGVD29)	3.92
Mean Diurnal Tide Level (DTL)	3.77
Mean Low Water (MLW)	1.87
North American Vertical Datum of 1988 (NAVD88)	0
Mean Lower Low Water (MLLW)	-0.48

A summary table for the anticipated hydraulic studies at this site is presented in Section 2-21.

2-2.6.1 Design of coastal shore protection projects (ER 1110-2-1407)

This site does not include coastal shore protection.

2-2.6.2 Effects on adjacent shores

Downstream of the site, the shoreline transitions from a river delta to a bluffed-backed beach. The primary risk is an increase in sediment loading which could affect downstream intertidal and sub-tidal habitats in the river delta portion. At the bluff-backed beach, the primary forcing processes are coastal wind waves and longshore sediment transport which are expected to be minimally if at all affected by the restoration. The effects on downstream and intertidal habitat should be evaluated during PED, using results from similar inlets in Puget Sound.

2-2.7 Navigation Projects

This site does not affect navigation (see Figure 2- 2-9). The nearest shipping lanes are over 4 miles away and separated from the site by Lummi Island.

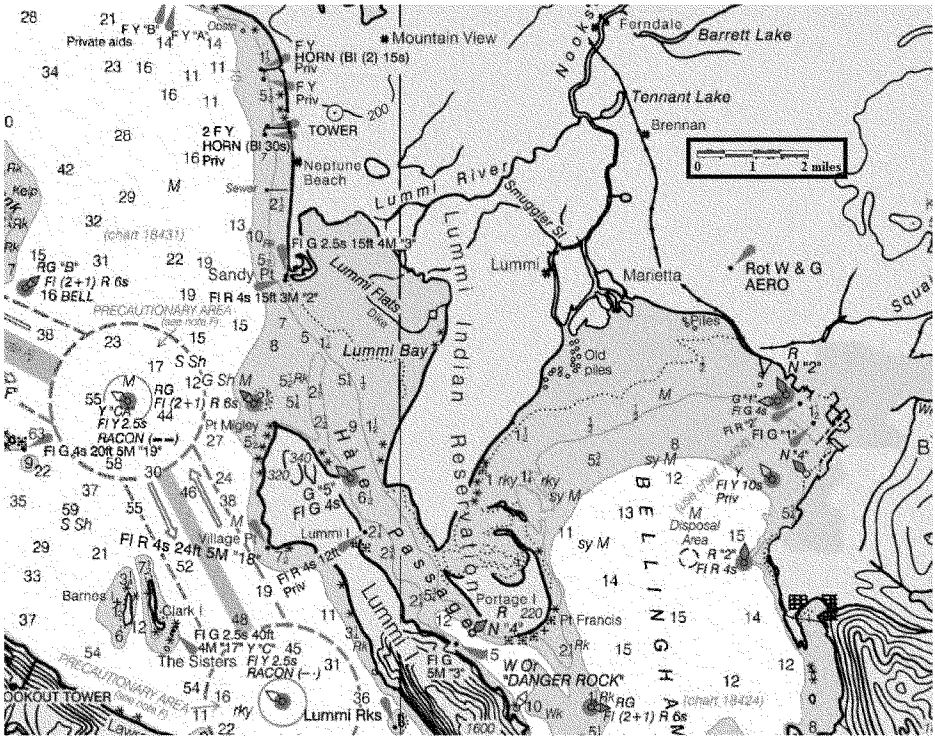

Figure 2- 2-9. Navigation chart for the vicinity of the Nooksack River Delta (Source NOAA RNC Online)

2-3 SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS

This section describes surveying, mapping, and other geospatial data information to support preparation of the FR/EIS and the *Real Estate Plan* (Appendix C of the FR/EIS). A brief outline of additional surveying and mapping required for subsequent design, plans and specifications, construction, and operations is also included.

2-3.1 Surveying, Mapping, and Other Geospatial Data Information Used

Geospatial data for the Nooksack River site were obtained primarily from remote sensing applications. No site-specific topographic, bathymetric, property, or utility snrveys were conducted dnring the conceptnal design phase. LiDAR, aerial imagery, and other geospatial data were used to delineate topographic features, determine surface elevations, and to estimate areas, volumes, lengths, and other dimensions of key features using CAD and/or ArcGIS. High-resolution LiDAR was obtained from the Puget Sound LiDAR Consortium (2005 LiDAR; 3m grid; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://pugetsoundlidar.ess.washington.edu/lidardata/index.html). The Puget Sonnd Digital Elevation Model was used for combined bathymetry and topography of the Puget Sound lowland (Finlayson D.P., 2005; University of Washington; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://www.ocean.washington.edu/data/pugetsound). Recent aerial photography (Whatcom Connty Planning and Development Services 2004) was evaluated to determine recent site conditions. The conversion from Mean Lower Low Water to North American Vertical Datum (NAVD88) was derived from the Bellingham tide gage (NOS 9449211).

Information on land ownership was derived from the Washington Public Lands Database. Additional parcel data, including parcel boundaries, was obtained from the Whatcom County assessors' office (2010). Information on utilities, existing roadway geometry, and other site features was generally scaled off of aerial photographs when as-built drawings were not available. A site reconnaissance was performed in October 2010.

Designers consnlted the Nearshore Geodatabase for additional site context. The Nearshore Geodatabase is available from the Washington State Geospatial Data Archive at: http://wagda.lib.washington.edu/data/geography/wa_state/#PSNERP. Metadata are provided in the *Geospatial Methodology Used in the PSNERP Comprehensive Change Analysis of Puget Sound* (Anchor QEA et al. 2009) (see Annex B). The geodatabase includes numerous datasets listed below:

- Shoreline
- Bathymetry
- Digital Elevation Model (DEM)
- LiDAR (terrestrial)
- Oblique aerial imagery (from the Washington Coastal Atlas)
- Hydrographic sheets
- Geology
- Slope stability
- Drift cells (net shore-drift)
- Streams
- Impervious surfaces
- Overwater structures
- Marinas
- Armoring
- Breakwaters/jetties
- Groins
- Dikes
- Dams
- Nearshore fill
- Roads
- Railroads
- Land cover

Designers also consulted the University of Washington Puget Sound River History Project 19th Century Coast Survey Topographic Sheets (2009) for information on historical geomorphologic conditions. Conceptual designs were intended to replicate historical conditions and remove stressors to nearshore processes to the extent practicable and feasible; as a result these datasets informed the selection of restoration strategies and features. Designers created additional GIS data layers (point files, line files, and polygon files) to represent civil design features snch as areas of lowland excavation to be depicted on the plan view drawings. Designers also created simple line drawings in CAD to represent typical sections and

estimate quantity take-offs. Limited surface modeling was used to aid new levee and existing levee excavation quantity take-offs.

2-3.1.1 Additional survey and mapping required

Substantial additional information will be required in PED to refine the design assumptions, confirm real estate requirements, and develop plans and specifications. Additional survey, mapping, and other geospatial data needs include the following:

- Property/Utility Survey – More detailed information on property boundaries and utilities will be needed to finalize the design and support real estate negotiations. The survey would also be useful in providing more accurate preliminary designs and quantities for roadways, utilities, bridges, and removal of existing features.
- Topographic/Bathymetric Survey – The conceptual design was based on LiDAR and aerial photos, which have inherent inaccuracies. Site-specific topographic and bathymetric survey data will be needed to refine design of key project elements and develop detailed construction and demolition plans. Survey data could also be used as a baseline for pre- and post-construction modeling, including hydrodynamic modeling. A temporary tide gage may be required in the early design stages to obtain site-specific tidal statistics.

2-3.1.2 Procedure for incorporation of new mapping or other geospatial data

Planning, design, and implementation are expected to take several years. The site-specific surveys identified above are standard components of the design process and should be completed in the early stages of PED to ensure that the design work proceeds efficiently. Incorporating these data into the design process is not expected to delay the restoration.

2-4 GEOTECHNICAL

This section describes the geologic setting of the site, previous and recommended studies, and proposed geotechnical explorations relevant to design features.

2-4.1 Geotechnical Information Used

2-4.1.1 Regional and site geology

Regional geologic mapping indicates the Nooksack River delta is composed of alluvium deposits (Dragovich et al. 2002). Alluvium deposits (Qa) consist of sorted combinations of silt, sand, and gravel deposited in deltas and alluvial fans. A section of the geologic map is shown in Figure 2-4-1.

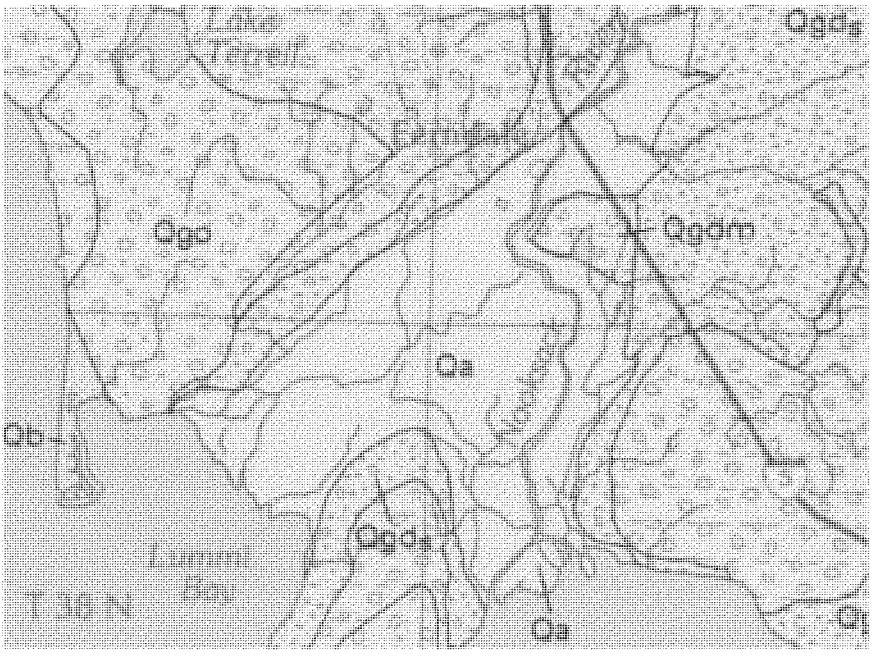

Figure 2-4-1. Geologic Map of Nooksack Delta

The *Soil Survey of Whatcom County Area, Washington* maps six soil types in the site vicinity: Eliza silt loam, Eliza-Tacoma silt loam, Hovde silt loam, Mt. Vernon fine sandy loam, Tacoma silt loam, and Whatcom-Labounty silt loam (Goldin 1992).

According to the Washington State Department of Ecology (Ecology) website, approximately 15 borings were conducted in the Nooksack River delta in October 2011 and April 2012. The wells and borings are located at the Silver Reef Hotel at 4876 Haxton Way and were drilled between depths of 23 feet and 101.5 feet. The driller's log indicates subsurface conditions typically consist of sandy silt and silty sand from the ground surface to the bottom of the hole.

Design drawings from 1967 for the Marine Drive Bridge over the Nooksack River include five borings along the alignment of the bridge. Borings varied in depth from 54 feet to 146 feet. The typical profile consists of loose to medium dense silty sand in the top 10 feet, loose to medium dense sand with shells from 10 to 30 feet, medium stiff silty clay with sand from 30 to 55 feet, medium stiff to stiff sandy silty

clay with gravel from 55 to 120 feet, stiff clay from 120 to 135 feet, and dense sand from 135 to 146 feet (bottom of hole).

In addition, design drawings from 1977 for the Marietta Slough Bridge, located 1,500 feet east of the Nooksack River Bridge; include two borings varying in depth from 69 feet to 75 feet. The typical profile consists of dense sand and gravel fill in the top 10 feet, loose to medium dense silty sand from 10 to 20 feet, loose sandy silt with shells from 20 to 30 feet, soft to medium stiff silty sandy clay from 30 to 60 feet, and dense sandy silt from 60 to 75 feet (bottom of hole).

2-4.1.2 Completed explorations

No subsurface explorations have been completed for this site. All subsurface information is based on soil surveys, geologic mapping, and logs from Ecology. See Section 2-4.3 for the proposed subsurface exploration plan.

2-4.1.3 Selection of preliminary design parameters

Based upon research of the soils and geology in the project vicinity, subsurface soils are likely to consist mostly of silt, sand, and clay. Preliminary design parameters have been selected for the types of soils that are likely to be observed at the proposed bridge foundation locations. Table 2-4-1 provides a range of preliminary design values for the anticipated soils in the foundation.

Table 2-4-1. Preliminary design parameters

Soil Description	Depth Range (feet)	Unit Weight, γ (pcf)	Friction angle, ϕ'
Loose to medium dense, silty sand	0 – 30	115-120	28°-30°
Medium dense, silty clay w/ sand and gravel	30- 60	105-115	26°-30°
Medium dense to dense, sand w/ silt	60 – 100	120-125	30°-34°

Groundwater table was assumed at the ground surface.

2-4.1.4 Geophysical investigations

No geophysical investigations have been conducted for this project. It is recommended that there be shear wave velocity measurements, such as a seismic refraction survey to define the site class since the geologic map shows loose materials. There is also the potential for liquefiable soils around the site.

2-4.1.5 Groundwater studies

No groundwater studies have been conducted for geotechnical design. Groundwater elevation is dependent on flows from the Red (Lummi) River, Nooksack River, and the water surface elevation of Puget Souud. The site spans over many square miles and the groundwater table may be variable. For geotechnical design purposes, the groundwater will be assumed at the ground surface when considering the bridge foundations.

2-4.1.6 Recommended instrumentation

No instrumentation is recommended for this site. (Not applicable.)

2-4.1.7 Earthquake studies

In accordance with Table 20.3-1 of the 2010 American Society of Civil Engineers (ASCE) 7, a Site Class C or D is recommended for this site when considering the average of the upper 100 feet. According to the 2008 United States Geological Survey (USGS) Earthquake Hazards website

https://geohazards.usgs.gov/deaggint/2008/, the Peak Ground Acceleration (PGA) predicted for the site is 0.410 g, and the maximum considered earthquake (MCE) ground motions for the site are Ss=0.934 g and S1=0.385 g. In accordance with Tables 11.4-1 and 11.4-2 from ASCE 7, Site Coefficients Fa and Fv are 1.1 and 1.6, respectively for a Site Class D. Therefore the adjusted MCE ground motions are SMS=1.028 g and SM1=0.617 g. The return interval for these ground motions is 5 percent probability of exceedance in 50 years (975 years). See Figure 2-4-2 below for earthquake deaggregation output.

Seismic design for deep foundations and bridge abutments will be performed in accordance with Washington State Department of Transportation (WSDOT) requirements and the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Seismic Design Specifications. (AASTHO specifies 7% in 75 years, which is comparable to USGS 5% in 50 years.)

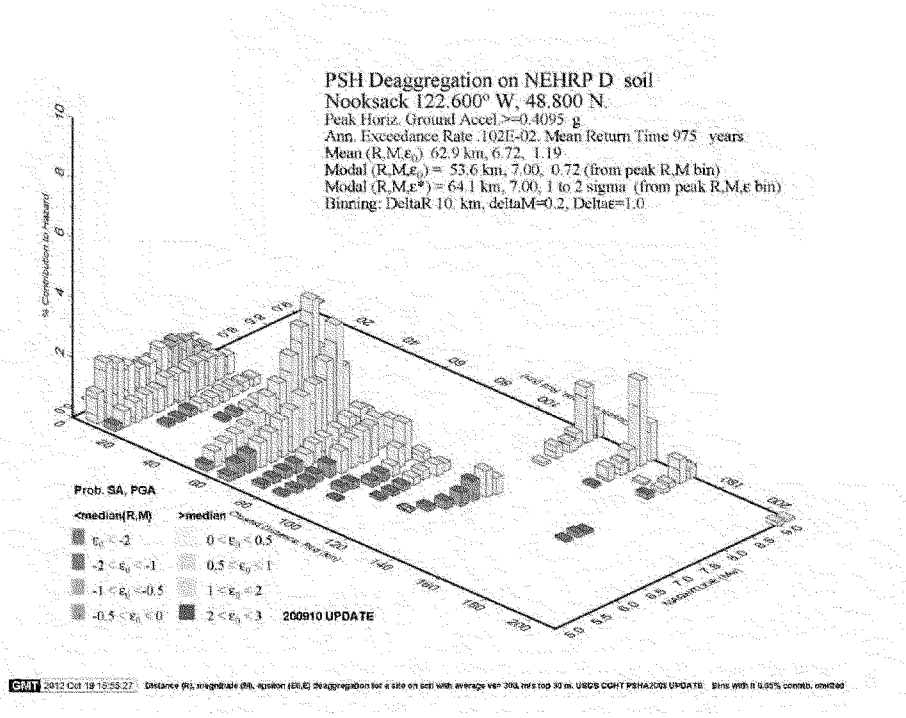

Figure 2-4-2. Deaggregation plot for Nooksack Delta

Earthquake loadings are not normally considered in analyzing the stability of levees because of the low risk associated with an earthquake coinciding with periods of high water. Depending on the severity of the expected earthquake and the importance of the levee and duration of flood event, seismic analyses to determine liquefaction susceptibility and stability may be required. However, this is not anticipated for this site.

2-4.1.8 Preliminary engineering analysis

Several bridges will be replaced to meet design goals. All bridges will be supported by deep foundations. Preliminary foundation estimates were included in the conceptual design for cost estimating purposes. The foundation design assumed two, 7-foot-diameter drilled shafts at each pier with a 100-foot

embedment depth. The information for the majority of the existing bridge foundations is currently unavailable.

Drilled shafts or driven piles are acceptable foundation alternatives for the proposed bridges. Shallow foundations are not an option at this time due to potential seismic loading, scour, liquefiable soils, and soft soils.

A preliminary estimate of foundation capacity using the lower range of the parameters in Table 2-4-1was used as a check on the foundation design from the conceptual design. See Table 2-4-2 , Table 2-4-3 and Table 2-4-3 for results of the estimate.

Table 2-4-2. Preliminary Foundation Axial Capacity Estimate for Ferndale, Slater, and Imhoff Roads at Lummi River

Feature	Description	
Bridge	Total length (feet)	250
	# of spans x Approx. span length (feet)	2 x 125
	Approximate width (feet)	44
	Dead load x 1.25 [LRFD strength I] (kips) / pier[1]	1,800
	Live load x 1.75 [LRFD strength I] (kips) / pier[2]	400
Foundation	Type	Drilled Shaft
	Diameter (inch)	84
	# shafts / pier	2
	Depth (feet)	100
Load	Estimated static loading demand (kips)	1,100
Capacity	Factored pile resistance (kips)	1,900
	Sufficient capacity	OK

[1] Dead load estimate is based on conceptual design bridge dimensions.

[2] Live load estimate is based on HL-93 (HS-20 Truck + 0.64k/ft lane).

Table 2-4-3. Preliminary Foundation Axial Capacity Estimate for Haxton Way and Hillaire Road at Lummi River

Feature	Description	
Bridge	Total length (feet)	450
	# of spans x Approx. span length (feet)	3 x 150
	Approximate width (feet)	44
	Dead load x 1.25 [LRFD strength I] (kips) / pier[1]	2,100
	Live load x 1.75 [LRFD strength I] (kips) / pier[2]	500
Foundation	Type	Drilled Shaft
	Diameter (inch)	84
	# shafts / pier	2
	Depth (feet)	100
Load	Estimated static loading demand (kips)	1,300

Feature	Description	
Capacity	Estimated pile capacity (kips)	1,900
	Sufficient capacity	OK

1 Dead load estimate is based on conceptual design bridge dimensions.

2 Live load estimate is based on HL-93 (HS-20 Truck + 0.64k/ft lane).

Table 2-4-4. Preliminary Foundation Axial Capacity Estimate for Slater Road at Tennant Creek

Feature	Description	
Bridge	Total length (feet)	390
	# of spans x Approx. span length (feet)	3 x 130
	Approximate width (feet)	44
	Dead load x 1.25 [LRFD strength I] (kips) / pier[1]	1814
	Live load x 1.75 [LRFD strength I] (kips) / pier[2]	417
Foundation	Type	Drilled Shaft
	Diameter (inch)	84
	# shafts / pier	2
	Depth (feet)	100
Load	Estimated static loading demand (kips)	1,115
Capacity	Estimated pile capacity (kips)	1,937
	Sufficient capacity	OK

1 Dead load estimate is based on conceptual design bridge dimensions.

2 Live load estimate is based on HL-93 (HS-20 Truck + 0.64k/ft lane).

Each end of the bridge will require an earthen abutment to tie into. If there is liquefaction potential found in the site soils, the abutments will need to be supported by 4 or more shafts that extend down to a stable depth, preliminarily set at 100 feet below ground surface.

Foundation capacity estimate is preliminary without any site specific subsurface information. Upon completion of subsurface explorations, foundation should be designed using encountered subsurface conditions. Downdrag on the drilled shafts shall also be analyzed. Foundation design shall include drilled shafts and driven piles as a comparison if deemed as a valid alternative. It should be noted that if liquefaction potential soils in the foundation are present, the depth of the drilled shafts or driven piles may increase. Likewise, if bedrock or dense or hard soil is encountered the depth of the drilled shafts will significantly decrease. Seismic loading, liquefaction potential, and scour are not included in the current conceptnal level design.

Slope stability analysis has not been evaluated at this time. Slope stability and settlement analysis for the entire approach embankments shall be performed upon completion of the design and geometrical configuration of the bridge. Ground improvements may be required at the bridge abutments/roadway approaches if liquefiable soils are encountered.

The proposed levee should be designed in accordance with the USACE Engineering Manual 1110-2-1913 Design and Construction of Levees. For levees constructed on soft subsurface conditions, stability and long-term settlement analyses are typically performed.

2-4.1.9 Excavatability analysis

According to the conceptual design, significant excavation will be required. Several thousand linear feet of levee and rock armor will be removed, a portion of the Lummi River will be excavated to increase capacity, and several roadway embankments will be removed for construction of new bridges and raised roads. No explorations or construction records were located, and therefore the levee and embankment material is unknown. Based on soils and geology maps, it may be assumed that the levee and embankment fill consists of compact sandy silt and structural fill. Excavation of riprap and fill may be accomplished using an excavator. Bedrock and boulders are not anticipated; therefore, rock excavation and blasting are unlikely.

2-4.1.10 Anticipated construction techniques and limitations

The type of deep foundation to be used will be confirmed during PED once subsurface explorations have been completed. At this time it is assumed drilled shafts will be used to support the proposed vehicle bridges. Due to the presence of soft and caving soils and anticipated high groundwater, either casing or wet method is recommended for construction of drilled shafts. Upon completion of the shaft excavation, the hole is cleaned and the reinforcing steel cage is placed to the bottom of the hole. The casing is then carefully extracted, fully or partially, leaving a top segment to facilitate column installation and concrete is cast. Once the shafts are installed, the columns are cast, and the pilecaps and bridge superstructure are constrncted.

Most of the earthwork will be accomplished with standard excavation equipment. Construction of roadways and setback levees may be accomplished year-round using dozers and excavators due to the existing dikes and drainage ditches. Excavation of the dike breaches and removal should be schednled to coincide with periods of low water.

Settlement may be observed along portions of the new levee, access levees, and roadway embankments. Depending on geotechnical evaluation, construction of the embankments may need a sure-charge, the work may be staged, or ground improvements may be advised to reduce post-construction settlement. Construction practices and methods outlined in the USACE Engineering Manual 1110-2-1913 Design and Construction of Levees are recommended for levee construction.

Construction activities and proposed restoration features will impact the existing utilities that run across the site. Evaluating the impact and protecting the utilities will be coordinated with service providers during later stages of design. See Section 2-6.2 for utility relocation information.

See Section 2-6.1.1 for additional construction notes.

2-4.1.11 Potential borrow sources and disposal sites

No borrow sources have been identified within the site. Substantial volumes of both borrow and disposal will be required. Due to the large footprint of the proposed restoration, it is likely that borrow and disposal sites can be found within the site boundaries. Suitability of local borrow materials for use in setback levees and elevated roads will be evaluated during later stages of design. Some land subsidence has likely occurred in the diked agricultural lands. Excavated materials may be disposed in subsided areas or in existing borrow ditches. Offsite disposal and borrow sites are available within a reasonable distance from the site. Multiple borrow and disposal sites are located along the Interstate 5 corridor within 30 miles of the site. Project plans include a 30 mile haul distance for levee and armor excavation, provision of fill material, a 20 mile haul distance for pavements and sidecast of channel excavations. Borrow and disposal sites shall be confirmed during PED. The uncertainties associated with confirming suitable borrow and disposal sites have been captured in the cost risk register.

2-4.1.12 Potential sources of concrete and materials

Preliminary investigations indicate that there are four concrete ready-mix batch plants located within 20 miles of the site and nine gravel suppliers within 30 miles.

2-4.1.13 Suitability of concrete and materials

Suitability of concrete and materials will be evaluated during PED.

2-4.2 Additional Studies and Analysis

Additional studies and analysis to be completed during PED or subsequent phases of design include the following at a minimum:

- Geotechnical Investigation: subsurface explorations, testing, and field reconnaissance
- Foundation Design: static and seismic analysis according to AASHTO LRFD for vehicle bridges
- Abutment Stability: include potential for liquefaction and ground improvement
- Pavement Design: new roadways and approaches (include traffic analysis for Equivalent Single Axle Load (ESALs))
- Scour Study: at roadway embankments, abutments, and bridge piers
- Settlement Analysis: for roadway and railway embankments
- Levee Design: stability, settlement, seepage analysis

2-4.3 Additional Explorations and Testing

The proposed subsurface exploration plan consists of drilling borings along the alignment of the proposed roadway and railway bridges. In addition test pits, cone penetrometer testing (CPT), and borings should be conducted along the roadway and railway embankments. Borings along the bridge alignments should occur at the abutments and at least one every pier, approximately every 110 to 150 feet (closer for the railway bridge). For the embankments, borings will be spaced approximately every 250 to 500 feet, with additional CPTs between the borings to provide additional parameters and an adequate soil profile along the proposed embankments. Test pits could be performed if needed for at-grade construction and pavement design.

Explorations for the proposed levees should be conducted in accordance with USACE Engineering Manual 1110-2-1913. This will include a combination of test pits and borings along the levee alignment. Depth of borings and test pits for the levee should be a minimum of 10 feet and spaced approximately every 200 feet. Test pits will be accomplished with a backhoe or small excavator, and the recommended boring method is mud rotary.

Based on research of the site and preliminary foundation design, the bridge borings should be a minimum of 150 feet below the ground surface, embankment borings and CPTs a minimum of 50 feet, and test pits a minimum of 10 feet. The preferred exploration method for the borings is mud rotary. Test pits will be accomplished with a backhoe or small excavator.

The subsurface exploration plan should be reevaluated and coordinated with hazardous and toxic material investigations during PED to include chemical sampling and testing; see Section 2-9.

Sampling in the soil borings should be accomplished using standard penetration test (SPT) with samples taken typically every 2.5 feet for the top 10 feet and every 5 feet for the rest of the boring depth. Proposed soil lab testing will include moisture content, grain size analysis, and percent finer than #200 sieve. Atterberg limits and consolidation tests are recommended for cohesive soils, and unconfined compressive strength test for rock cores.

2-4.4 Laboratory-Testing Program and Evaluations

No laboratory testing or evaluation of materials has been completed at this time. Testing to be completed during PED is outlined in Section 2-4.2.

2-5 ENVIRONMENTAL ENGINEERING

This section describes environmental engineering factors relevant to the proposed design features.

2-5.1 Use of Environmentally Renewable Materials

At this design stage, use of environmentally renewable materials is not specifically planned, but will be considered wherever applicable during PED. If renewable materials are available, they can be incorporated into the design during PED, or sourced by the contractor during construction. Specific details will be developed during PED.

2-5.2 Design of Positive Environmental Attributes into the Project

The Nooksack River Delta is selected to address River Delta restoration objectives to restore freshwater input and tidal processes where major river floodplains meet marine waters. The proposed restoration would remove levees, roads, and other barriers to restore water and sediment processes throughout a substantial portion of the historical Nooksack River delta. This restoration contains multiple components: deconstruct and reconstruct roadways, build new setback levees, breach river banks, remove channel fill, and fill linear ditches. The restoration has been developed to retain agricultural area, reduce the efforts and costs of changing transportation infrastructure, and be consistent with the proposals for the Lummi Nation Wetland and Habitat Mitigation Bank.

2-5.3 Inclusion of Environmentally Beneficial Operations and Management for the Project

Design and construction will incorporate sustainable and ISO 14000 compliant practices for operations and management. The USACE Environmental Operating Principles (EOPs) are designed to provide direction on achieving better stewardship of air, water, and land resources while showing the connection between managing those resources and protecting environmental health. The EOPs are to ensure that USACE actions consider the environment and are sustainable now and in the future.

2-5.4 Beneficial Uses of Spoil or Other Project Refuse during Construction and Operation

At this design stage, beneficial use of spoil or other refuse is not planned. If spoils or other refuse materials are available for reuse, they could be incorporated into the design. Specific details will be developed during PED.

2-5.5 Energy Savings Features of the Design

At this design stage, energy savings features have not been incorporated. In accordance with the EOPs, energy savings features will be a component of the design to the maximum extent practicable.

2-5.6 Maintenance of the Ecological Continuity in the Project with the Surrounding Area and Within the Region

The restoration will increase ecological continuity in the site and with the surrounding area. This is one of several sites designed to restore the productivity and increase interconnectivity of the Puget Sound ecosystem.

2-5.7 Consideration of Indirect Environmental Costs and Benefits

All direct, indirect and cumulative environmental costs and benefits were evaluated during the environmental impact assessment and alternatives analysis recorded in the Final FR/EIS.

2-5.8 Integration of Environmental Sensitivity into All Aspects of the Project

Construction will be conducted to ensure no long-term deleterious impacts to the ecosystem will occur. Best management practices will be incorporated into the contract documents. Best management practices will cover erosion and sediment control, stormwater management, spill response and hazardous material management, trash and debris management, air emissions from construction vehicles, and noise standards.

2-5.9 Use of Environmental Review Guide for Operations (ERGO) with Respect to Potential Future Environmental Problems

This is not a USACE operating facility. (Not applicable.)

2-5.10 Incorporation of Environmental Compliance Measures into the Project Design

All applicable laws and regulations will be followed during design and construction in accordance with the USACE contract documentation.

2-6 CIVIL DESIGN

This section discusses the key elements of the civil design, including the selection of the site, basis of design, and constructability.

2-6.1 Site selection and project development

Restoration in the Nooksack River Delta represents a large-scale opportunity to restore a substantial portion of a large river delta that drains approximately 825 square miles. The proposed Nooksack River restoration combines multiple elements intended to restore the natural hydrologic, sediment, and ecological processes to a substantial portion of the Nooksack and Lummi deltas. The proposed restoration activities include the following:

- Armor removal for streambank restoration and reconnecting floodplain habitat
- Dike removal or modification for floodplain freshwater marsh restoration
- Setback levees for floodplain reconnection and side channel development
- Riparian revegetation for shading, nutrient inputs, and complexity of bank habitat
- Large wood placement for increased habitat complexity
- Hydraulic modification: partial restoration of river flow to Lummi River through installation of water control structure at confluence of Lummi and Nooksack Rivers; strncture intended to facilitate transfer of freshwater and sediment to the Lummi River
- Topography restoration: regrading of the Lummi River to allow for more frequent engagement by fluvial flows from the upper watershed
- Non-structural measure: residential relocations

The main restoration elements are shown in Table 2-6-1 and described in detail in the following sections. Annex 2-1 contains exhibits that depict the proposed restoration design elements.

Table 2-6-1. Key Design Elements

Item	Description of Item	Approx. Quantity
Nooksack River		
Install New Setback Levee and Relocate Ferndale Road	Set back right bank levee to Ferndale Road alignment between Slater Road and Marine Drive. New levee will be 12,633 lf with a typical section of 600 sf. Will include new paved road on the crest	346,100 cy
Remove Portions of Existing Levees on Both Banks	Remove approximately 60% of right and left bank dikes from the Slater Road to near Marine Drive. Total length of 12,280 lf.	93,800 cy
Install Log Jams in Mainstem Nooksack	Install large wood structures within Nooksack mainstem to assist geomorphic response of the river in concert with setting back the levees (location to be determined)	3 structures
Lummi River		
Install New Water Control Structure at Confluence	Upstream Lummi River connection to Nooksack River to be regulated via an engineered diversion structure that will be designed during PED. This structure is intended to facilitate transfer of freshwater and sediment to the Lummi River, while preventing avulsion of the mainstem to the west.	1 ea
Regrade Lummi River Channel and Berms. Remove North Red River Road West of Haxton	Regrade existing Lummi River channel to install 0.04% bed slope and larger channel cross section to better match invert to water surface elevation of the Nooksack River, increase conveyance capacity, and create surface to encourage geomorphic processes. Regrade would occur over the upper 9,980 lf of the channel, with a typical section of 285 sf in the upper 5,000 lf and 80 sf in the lower 4,890 lf.	67,300 cy
	Remove existing berm and road along north side of Lummi River west of Haxton Way. Length of berm to be removed and associated volumes are: west to Hillaire=3843 lf 10,659 cy; Hillaire to Haxton=5927 lf, 13,017 cy; Haxton to Slater=1981LF, 7,176 cy.	30,900 cy
Build New Setback Levees	Install setback levee on south side of the Lummi River channel between Haxton and Ferndale. Length is 11,232 lf with typical section of 175 sf.	84,500 cy
	Install setback levee on the north side of the Lummi River channel from the valley margin to the Ferndale Rd and realign North Red (Lummi) River Road away from channel. Length is 23,025 lf with typical sections varying from 135 sf/lf to 432 sf/lf based on levee heights 5 to 8 feet, crown elevations varying from approximately Elevation 15 to 20 NAVD88.	313,000 cy

Item	Description of Item	Approx. Quantity
Transportation Improvements		
Modify Slater Road at Lummi River	Remove bridge and a portion of the existing roadway.	450 lf
	Raise Slater Road (build new roadway)	200 lf
	Build new bridge (two 125-foot spans) over Lummi River to span new set back levees	250 lf
Modify Slater Road at Tennant Creek	Remove a portion of the existing roadway (and culvert)	5600 lf
	Add bridge on Tennant Creek to allow 100-year flow to pass below the bridge after culvert removal.	390 lf
	Install causeway along Slater from eastern upland to Ferndale Road to maintain emergency access/egress during floods.	5,600 lf
Modify Haxton Way	Remove bridge and a portion of the existing roadway	1,300 lf
	Build new bridge (three 150-foot spans) over Lummi River to span new setback levees	450 lf
	Install new road approaches	200 lf
Re-align North Red River Road and Haxton Way	Remove existing roadway	11,751 lf
	New road on top of setback levees (30-foot width)	9,216 lf
Modify Hillaire Road at Lummi River	Remove Bridge and a portion of the existing roadway	575 lf
	Build new bridge (three 150-foot spans) over the Lummi river to span new setback levees	450 lf
	Build new roadway	200 lf
Modify Imhoff Road at Lummi River	Remove a portion of the existing roadway (and culvert)	400 lf
	Build new bridge (two 125-foot spans) over the Lummi River	250 lf
	Build new roadway	150 lf
Modify Ferndale Road at Lummi River	Remove a portion of the existing roadway (and culvert)	650 lf
	Build new bridge (two 125-foot spans) over the Lummi River.	250 lf
	Build new roadway	12,200 lf
Modify Marine drive between Marine Drive Bridge and Kwina Slough	Raise a portion of existing roadway to maintain emergency access/egress during floods.	3,500 lf

2-6.1.1 Basis of design

The proposed restoration would increase the area of aquatic and floodplain habitats along both the Nooksack and Lummi Rivers, but would retain a level of engineering control that would minimize changes to land use on much of the delta. The restoration of this site is designed to restore ecosystem processes and reestablish natural geomorphic conditions. The civil design is based in part on historical conditions as evidenced by 19th Century Coast Survey Topographic Sheets (Figure 2-6-1). In other words, post-restoration site conditions are intended to resemble or replicate the historical morphology with adjustments for altered surrounding conditions. For the Nooksack/Lummi delta, the restoration would not match historical conditions because it would leave the Nooksack (east) side of the delta as the primary conduit for water and sediment.

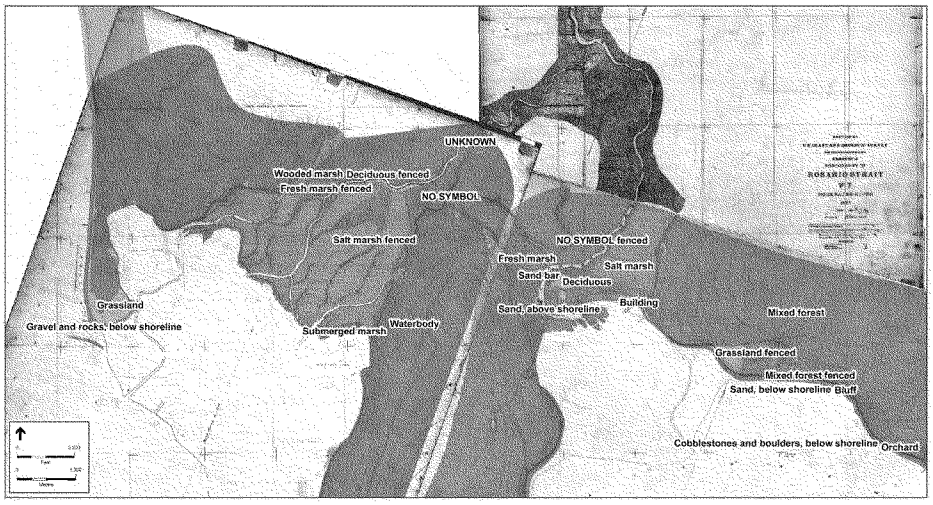

Figure 2- 6-1. Historic Map (T-Sheet) and River History Project Data

A network of transportation corridors has been developed over the delta, and much of the area supports active agricultural operations. The proposed restoration would retain agricultural area, reduce the efforts and costs of changing transportation infrastructure, and be consistent with the existing proposals for the Lummi Nation Wetland and Habitat Mitigation Bank. Changes to the existing infrastructure system are described below.

Levee Removal and Levee Breaches

The levees/berms along the Nooksack River the levee along the Lummi delta, and the plugging of the Lummi River channel have eliminated important floodplain slough and distributary channel habitats, and eliminated or greatly reduced key geomorphic processes. The partial removal and setback of levees along the Nooksack River would restore these geomorphic processes. Near-term effects include the connection of the river and tidal areas to the floodplain/marsh. In a long-term analysis, the removal/setback of the levees would decrease the relative amount of stream power constricted within the presently leveed reach of the river, with a resultant increase in sediment deposition in the channel and floodplain. Sediment deposition—in conjunction with engineered log jams that would cause hydraulic constrictions—would increase stage relative to discharge. This is desirable in increasing the connection of the Lummi River to the Nooksack River at progressively decreasing discharge levels through time. Optimally, the Lummi River would become connected to the Nooksack River at all discharge levels.

There is some risk that the levee breaching may not provide the hydraulic response needed to restore geomorphic processes. Thus, the volume estimates conservatively assume that nearly 60% of the levee

length must be removed, even though some hydraulic studies (Whatcom County Department of Public Works 1999) suggest that floodwaters access the left-bank floodplain upstream of the site. Subsequent design may determine that removing and/or breaching the levees in phases may be beneficial in balancing the need to connect the water surface elevation of the Nooksack River to the Lummi River channel with the need to aggrade the Nooksack River channel to engage the Lummi distributary channel at progressively lower discharge levels. Such balancing would be assessed during later modeling in PED.

Setback and strategic breaches in the levees that border the Lummi River delta will restore tidal flux to a substantial portion of the western delta. As part of the proposed Lummi Nation Wetland and Habitat Bank, the seapond will remain and access would be maintained from Hillaire and Kwina Roads. Portions of the levee system west of the Lummi River would be breached, and the tide gates on the levee east of the Lummi River would be replaced with self-regulating tide gates or similar. The self-regulating tide gates would be designed to allow substantial tidal flux during normal flow conditions, but would remain closed during storm events. A setback levee would be installed to protect the golf course at the west end of the site.

Channel Creation and Rehabilitation

The upper 9,500 feet of the Lummi River channel would be regraded to allow for more frequent engagement by fluvial flows from the upper watershed. The Lummi River appears to be perched on deltaic sediments remaining from when most of the flow was directed west to Lummi Bay. Further, the mainstem Nooksack River has been leveed, and flow into the Lummi River is via a relatively small culvert.

Connectiug the Nooksack River to the Lummi River would enable distributary flow into the Lummi River at essentially all discharge levels; this would provide a sustained freshwater connection, enhance water quality, and increase habitat. Because the head of the Lummi River channel is substantially disconnected from the Nooksack River channel, the connection to the river includes rehabilitation of the Lummi River channel to more closely approximate water stages that occur within the Nooksack River. If actions are not taken to include flow into the Lummi River distributary channel at lower discharge levels, the restoration benefits would be more transitory and limited to periods when the Nooksack River is flooding. This may or may not coincide with times when water quality in the Lummi River wonld be substantially improved by upstream inputs of fresh water.

The proposed restoration includes an engineered diversion structure in the right-bank levee of the Nooksack River to allow some flow into the Lummi River. To account for potential future changes in the stage-discharge relationship of the Nooksack River at this location, the structure would likely include some level of adjustment so that only the allowable discharge levels for which the downstream channel is designed are conveyed into the Lummi River. As currently designed, the setback levees along the Lummi River would not provide flood risk management in the event the mainstem were to avulse to the west.

The Lummi River has been highly modified in the last 150 years, including straightening and narrowing the channel. In its upstream extent, the Lummi River is very small (the field estimates suggest it may only convey approximately 150 cfs or less) and would be rehabilitated (enlarged) as part of the restoration. This would include lowering the Lummi River channel in its upper reaches, as well as grading and channel expansion to increase geomorphic processes and create habitat. Setback levees and floodplain grading are designed to confine Nooksack River overflow to within the Lummi River floodway without flooding across the delta.

Modifications to the Transportation System

Roads through the Nooksack River delta provide key transportation connections to portions of the Lummi Indian Reservation and the only access to the Lummi Island ferry. As noted in the 2015 FEMA Flood Insurance study:

> "Flooding along Nooksack River frequently causes closures of Slater Road and Marine Drive (the two primary access roads to the Lummi Indian Reservation and Lummi Island and is the main transportation corridor to two of the industries in the Cherry Point Heavy Impact Industrial Zone). Marine Drive is closed even more frequently than Slater Road by Nooksack River floods and is always closed due to flooding whenever Slater Road is flooded. Marine Drive was closed at least 17 times over a three-year period (2007-2010) with the longest continuous closure of 13 days

in November 2009 and a total closure time of 54 days (Lummi Nation Multi-Hazard Mitigation Plan 2010 Update). When both roads are closed, access to the Reservation, the Lummi Island ferry, and the Cherry Point industries is through, or to the north of, the City of Ferndale, approximately 2 miles north of Slater Road. This detour can more than double travel times to and from Bellingham and result in severe congestion in the City of Ferndale. These road closures have substantial impacts on the economic, public health, and safety of the affected areas."

Much of the existing system of bridges and roads through the delta will have to be modified to allow for successful restoration of water and sediment processes. Modifications to roads and bridges on the delta at and east of Ferndale Road include Ferndale Road at the Lummi River; Slater Road at Tennant Creek; and Marine Drive. Modifications on the west side of the delta include Hillaire Road at the Lummi River, Imhoff Road at the Lummi River, Slater Road at the Lummi River and and Haxton Way at the Lummi River/Smuggler's Slough.

In general, bridges with larger spans would be added to allow for channel migration and greater flood flow conveyance. Bridges are described in detail below in Section 2-7. Bridge spans over the Lummi River were sized to match the proposed levee setback and channel geometry to be controlled by the engineered diversion structure on the mainstem Nooksack River. Bridge spans on Tennant Creek were developed based on previous plans, which are assumed to be based on site-specific hydraulic investigations (DEA 2007). All bridge designs will need to be re-evaluated during PED to conform to design decisions regarding the Lummi diversion structure, setback levee locations, and hydraulic criteria.

Stormwater runoff from the project is required to meet Federal Energy Independence Security Act (EISA), State, Washington State Department of Ecology and local requirements. EISA requires sites in excess of 5000 square feet to retain the total volume of rainfall from the 95th percentile of the 24-hour storm on site. The alternative is to require the post development hydrology to not exceed the pre-development hydrology (prior to man) by using site specific stormwater BMP's such as infiltration, evapotranspiration and detention. WSDOE requires that the duration of the developed storm flow be less than 50% of the 2 year through the 50 year events. The WDOE water quality provisions require that treatment facilities be designed for the 24- hour storm with a 6-month return frequency or a simulated daily volume that accounts for 91% of the entire runoff volume over a multi-decade period of record.

For feasibility design, a provision for stormwater is included in the estimate. Once the site hydrology is confirmed in PED, stormwater detention will be designed where required. The risk of the assumption for stormwater treatment size has been captured in the Cost and Schedule Risk Analysis.

Refer to the exhibits for a depiction of restoration elements and the quantities and dimensions used in cost estimation. During PED phase the PDT will examine trade-offs and engineer the recommended alternative to minimize costs while optimizing desired benefits. This will be accomplished once the site investigations and surveys recommended for PED have been completed.

2-6.1.2 Constructability

Earthwork would require mobilizing heavy equipment to the site. Access to the site can occur via the existing system of county and farm access roads. Temporary traffic control would be necessary during construction removal.

Potential borrow sources and disposal sites are discussed in Section 2-4.1.11.

See Section 2-10 for additional information on construction procedures and Section 2-20 for the anticipated schedule for construction.

2-6.1.3 Real estate

Real estate assumptions, valuations, and planning documents have been appropriately scaled for the current level of design. As additional surveys, modeling, and design are completed during PED, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Final FR/EIS, Appendix C, *Real Estate Plan*.

2-6.2 Relocations

While information about utilities on the site is currently unknown, several utilities will probably need to be relocated to follow the new bridge and roadway alignments. These relocations will be coordinated and permitted with the utility owner. A utility survey will be completed during PED. In addition, land requirements, easement, and/or franchise agreements will be identified and coordinated.

2-7 STRUCTURAL REQUIREMENTS

This section discusses the structural elements of the proposed restoration including preliminary design requirements aud criteria for bridges or roads, a description of major structures and construction considerations, and recommended analyses.

2-7.1 Functional Design Requirements and Technical Design Criteria

Roads through the Nooksack River delta provide key transportation connections to portions of the Lummi Indian Reservation and the only access to the Lummi Island ferry. Much of the system of bridges and roads through the delta will need to be modified to allow for successful restoration of water and sediment processes.

Modifications to roads and bridges on the delta at and east of Ferndale Road include Ferndale Road at the Lummi River, Slater Road at Teunant Creek and Marine Drive. Modifications on the west side of the delta include Hillaire Road at the Lummi River, Imhoff Road at the Lummi River, Slater Road at the Lummi River and Haxtou Way at Lummi River/Smuggler's Slough.

The AASHTO Seismic Design guide specifications are intended for conventional bridges designed for the life safety performauce objective considering a seismic hazard corresponding to a seven percent probability of exceedauce iu 75 years. This implies that a bridge, when following these specificatious, has a low probability of collapse in a 1000-year event but may suffer significant damage and that significant disruption to service is possible. Partial or complete replacement of the bridge may be required. A higher level of seismic performance may be selected by a bridge owner who wishes to have immediate service and minimal damage following a rare earthquake. Seismic engineering analysis and design costs as well as construction costs should be expected to increase as the post-earthquake performance objectives are increased.

Whether a bridge is considered "regular" or "not-regular" is a function of its physical characteristics. A regular bridge is a bridge that has fewer than seven spans, no abrupt changes in weight, stiffness, or geometry. Regardless of its regularity, a bridge shall be designed with earthquake resisting systems (ERS) correspondiug to the requirements of a Seismic Design Category (SDC) of C or D (typical for the Puget Sound regiou). As such, the regularity was not assumed to impact construction costs directly for this level of design. Determination of the Seismic Design Category, SDC, is based on the parameters identified in Section 2-7.9. A category of D would result in more complex analysis and detailing requirements. This suggests an increase in both the design and construction costs associated with the foundations, columns, and connectivity between these structural components.

An important criterion for selecting road bridges for this site is to provide a simple and repetitive structural concept facilitating a healthy bidding climate; one that meets the goals stated below and is considered, within industry standards, to be a cost-effective solution.

The key design requiremeuts for the road bridges are to identify a cost-effective, coustructible bridge structure that will support traffic, provide for prescribed horizontal and vertical hydraulic openings, require minimal capital to maintain, meet the AASHTO Bridge and Geometric design specifications and WSDOT Bridge Design Manual specifications, and have a design life of no less than 75 years.

The bridges will be constructed of concrete shaft foundatious, concrete piers, pre-stressed coucrete girders, and a concrete deck. Concrete is a high-quality, dense mix design that should remain functional throughout the life of the bridge with minimal maintenance.

Pre-stressed concrete girders consist of a very high-quality concrete; they are the most common type of girder used in Washington because of superior local fabrication skills and the availability of high-quality local aggregate. Pre-stressed concrete girders are lower-maintenance structures than their steel counterparts and are competitively priced with steel girders. The economy in structural design can be achieved by designing around the standard girders from the Bridge Design Manual Span Capability Sheets as long as the selected standard design meets the geometrical requirements of the particular bridge. Deep shafts are used in liquefiable soils which are commonly found in the flat tidal zones of the Puget Sound region. The design objective is to extend the foundation shafts through the liquefiable soils and embed them deep into the underlying glacial soils to provide the necessary lateral support for the structure during a seismic event. Additional design details are noted as follows:

- In general, new bridges with longer spans will be added to allow for channel migration and greater flood flow conveyance and transfer. New bridges will be 44 feet wide, with span lengths ranging from 110 to 150 feet. Girders will be 6.5 feet deep, pre-cast concrete. New roadways will have two 12-foot lanes with two 8-foot shoulders.

- Bridge spans over the Lummi River are sized to match the proposed levee setback and channel geometry to be controlled by the engineered diversion structure on the mainstem Nooksack River. The bridge spans on Tennant Creek were developed based on previous plans, which are assumed to be based on site-specific hydraulic investigations (DEA 2007).

Key design elements are identified in Table 2-7-1. These proposed new bridges will achieve significant restoration benefits without high social or economic costs.

Table 2-7-1. Summary of Bridge Information

Bridge Location	Description
Ferndale Road at Lummi River	• New 250-foot-long bridge (two 125-foot spans), 44-feet wide, estimated low chord at El. 24 ft. NAVD88 • 6.5-foot pre-cast concrete girders with 1-foot concrete slab • (1) 44-foot CIP concrete pilecap with (2) 4-Foot diam. columns atop (2) 7-foot-diameter drilled shafts; 100 foot embed at each pilecap • Remove 650 feet of roadway. Add 400 feet of new roadway • Construction Duration: 10 months
Slater Road at Lummi River	• New 250-foot-long bridge (two 125-foot spans), 44 feet wide, estimated low chord at El. 19 ft. NAVD88 • 6.5-foot pre-cast concrete girders with 1-foot concrete slab • (1) 44-foot CIP concrete pilecap with (2) 4-Foot diam. columns atop (2) 7-foot-diameter drilled shafts; 100-foot embed at each pilecap • Remove 450 feet of existing road. Add 200 feet of new roadway • Construction Duration: 10 months
Slater Road at Tennant Creek	• Raise Slater Road per DEA (2007) plans and add a new 44-foot-wide, 390-foot-long bridge (three 130-foot spans) on Tennant Creek to allow 100-year flow to pass below the bridge, estimated low chord at El. 21 ft. NAVD88 • (2) 44-foot CIP concrete pilecaps with (2) 4-Foot diam. columns atop (2) 7-foot drilled shafts; 100-foot embed at each pilecap. • Include temporary detour route • Construction Duration: 18 months

Bridge Location	Description
Hillaire Road at Lummi River	• New 450-foot-long bridge (three 150-foot spans), 44 feet wide, estimated low chord at El. 14 ft. NAVD88 • 6.5-foot–deep, pre-cast concrete girders with 1-foot concrete slab • (2) 44-foot CIP concrete pilecaps with (2) 4-Foot diam. columns atop (2) 7-foot drilled shafts; 100-foot embed at each pilecap • Remove 575 feet of existing road. Add 200 feet of new roadway • Construction Duration: 12 months
Imhoff Road at Lummi River	• New 250-foot-long bridge (two 125-foot spans), 44 feet wide, estimated low chord at El. 20 ft. NAVD88 • 6.5-foot-deep pre-cast concrete girders with 1-foot concrete slab • 44-foot CIP concrete pilecaps with (2) 4-Foot diam. columns atop (2) 7-foot drilled shafts; 100 feet embed at each pile cap • Remove 400 feet of existing road. Add 400 feet of new roadway • Construction Duration: 10 months
Haxton Way at Lummi River	• New 450-foot-long bridge (three 150-foot spans) over Lummi River, 44 feet wide, estimated low chord at El. 15.5 ft. NAVD88 • 6.5-foot-deep pre-cast concrete girders with 1-foot concrete slab • (2) 44-foot CIP concrete pilecaps with (2) 4-Foot diam. columns atop (2) 7-foot drilled shafts; 100 feet embed at each pilecap • Remove 1,300 feet of existing road. Add 200 feet of new road • No change at Smuggler's Slough • Construction Duration: 10 months

The bridge design will be reviewed and approved by Whatcom County Public Works. The design will conform to the most current edition of the standards listed in Table 2-7-2.

Table 2-7-2. Structural Requirements

Item	Description
Design Specifications	• WSDOT Bridge Design Manual, current edition • AASHTO LRFD Seismic Bridge Design, current edition • AASHTO LRFD Bridge Design Specifications, current edition
Load Criteria	• Live Load: HL-93 (HS-20 Truck + 0.64k/ft lane), 1.3 Impact Factor • Load Combinations: Per Table 3.4.1-1 LRFD (Load Combinations and Load Factors) • Pedestrian (if required): 75 psf • Dead: Concrete = 0.16 K/cu ft, Steel 0.49 k/cu ft.

2-7.2 Survey, Hydrologic, Hydraulic, and Geotechnical Data Used

LiDAR survey and probable water surface elevations were used to develop the conceptual plan. For information about data used for the conceptual design, see Section 2-3.

No geotechnical data were available at the time of the conceptual design. Numerous borings will be required at each bridge location to facilitate development of an accurate cross section of the geology below the bridge. Typically, the borings should extend to about 150 feet below ground. During the conceptual design phase, the typical nearshore soil characteristics of Puget Sound were considered in selecting the bridge foundation type. Geotechnical investigations will be required for completion of PED; see Section 2-4.3.

2-7.3 Site Selection Studies

The site selection is summarized in Section 2-6.

2-7.4 Major Structures

Several technical considerations were used to decide on the type of bridge for the site, including: a cost effective structure that provides a hydraulic opening meeting the restoration goals, sufficient geometrical and structural capacity to safely meet the traffic demands, and sufficient capacity to meet seismic demands. Hydraulic openings are affected by bridge length and distance between piers. Bridge superstructure depth is affected by span length. Subsequent design may refine the conceptual plans in terms of bridge type, size, and location. The basis of design at the conceptual phase established the following parameters:

Span Length: In general, span length is highly influenced by the minimum or desirable hydraulic goals. Other factors that can affect the span length are good soils for foundations, minimizing piers in the waterway, achieving sufficient space at the banks to gain inspection access below the bridge, and the elevation of the water in the 100-year flood. Bridges range from 250 to 450 feet long. Longer bridge spans will allow for channel migration and greater flood flow conveyance and transfer. New bridges will be 44 feet wide, with span lengths ranging from 110 to 150 feet.

Bridge Type: The recommended bridge type is a pre-cast, pre-stressed concrete girder bridge. This means the deck is supported by girders below the roadway. The girders are supported by cap beams which comprise the transverse beam of the pier system. The bridges proposed for this site are continuous bridges. This means that they will have no intermediate joints between abutments and provide for a continuous deck over the piers. This allows for a structurally efficient system, reducing the girder depth, but also restricts leakage of water from the deck onto the piers by eliminating expansion joints. The bridge deck and girders will have expansion capabilities at their abutments.

The girders will be constructed of pre-cast, pre-stressed concrete, fabricated offsite and shipped by truck to the site for installation. Standard WSDOT pre-cast concrete girders are an efficient and economical bridge type for continuous span construction.

Depth of Structure: It is assumed at the conceptual design that the bridges will have a depth of 6.5 feet. The bottom of the bridge soffit (low point) is set at 3 feet above extreme high water (EHW) to provide adequate clearance for debris. This places the bridge deck at a minimum elevation of 17.7 feet in tide-dominated areas and a minimum elevation of 27.0 feet at Ferndale Road where the fluvial Nooksack flood regime will determine high water levels.

Alignment Considerations: See Section 2-6 for alignment considerations.

2-7.5 Evaluation and Selection of Substructure Alternatives Based on Economy and Performance

These bridges are located in a nearshore riverine environment, likely requiring deep foundation types. The geotechnical engineer will make final recommendations based on data obtained from the onsite boring logs and the structural engineer. See Section 2-4 for additional information.

The soils are likely to experience liquefaction during an earthquake. As such, the shafts will have to extend downward through the soft materials to stiff glacial soils for a solid fixed embedment.

The cost comparison between types of deep foundations (piles versus shafts) does not always result in a clear cost advantage for either foundation type. Many factors come into play such as availability of equipment to a contractor, a contractor's preferred method, the depth of the footing and the ease of access, construction schedule, and depth of foundation. In general, cost is not a determining factor for deep foundation type. Forces, displacement, and geological conditions will determine which system is best to use.

General and local scour are always a consideration with deep foundations. Subsequent design will include a hydraulic scour analysis. Protection of the structure from hydraulic scour may compete with the goals of the restoration. Preliminary design will evaluate these considerations and mitigate accordingly.

2-7.6 Construction Considerations

For bridge construction, a crane positioned on one end of the bridge will be required to set the girders in place. Work is anticipated to require land-based driving rigs or large augers to dig the shaft holes. Other equipment may include excavators, cranes, concrete trucks, and dump trucks. Placing foundations can be a challenge and may require temporary fill areas to facilitate the heavy cranes. It is assumed that the contractor will be able to install one shaft per week. In areas near the slough, large-diameter shoring will be required to keep out water and allow access to the top of the shaft for column form placement and removal. Once the shafts are installed, the columns are cast inside a shoring casing. After the casing is removed, the cast-in-place pile caps and bridge superstructure are constructed.

The construction duration for each bridge is noted in Table 2-7-1.

2-7.7 Stability Analyses

Bridge stability is a fundamental component in the design process and depends on boundary conditions. In general, the bridges are made stable by fixity in the soil/ structure relationship, fixity between the cap beams and the foundation elements, and designing/detailing for unbalanced loads. Longitudinally the bridge superstructnre is held in position and restrained dnring earthquakes by positive connectivity to each intermediate pier, either "pinned" (combined with shear keys) or "fixed." The bridge superstructure, however, is allowed to expand at each abutment. Transversely the bridge is tied together along its length, fixed or pinned to each pier, and designed to transfer all transverse loads directly to the foundation.

2-7.8 Stress Analyses

Stress analyses are a fundamental component in the design process and serve as the basis of how all structural elements are selected. Design will be in accordance with governing standards of the WSDOT Bridge Design Manual and the AASHTO LRFD Manual.

2-7.9 Seismic Analyses

All seismic analyses are performed in compliance with the WSDOT requirements and the AASHTO LRFD Seismic Design Specifications. This site is located in an active seismic zone. Bridges will be designed for a seismic event with a 7% probability of exceedance in 75 years (approximately a 1,000-year return period).

The essential seismic parameters to develop the Design Response Spectrum are arrived at by the geotechnical engineer, if site specific; see Section 2-4.1.7 for details of the seismic analysis.

2-7.10 Thermal Stress Analysis

Thermal analysis is a fundamental component of the design process and will be considered per the AASHTO LRFD design specifications. In general, thermal stresses are handled by providing expansion joints in strategic locations to permit a bridge to expand and contract without a large buildup of stresses or movement.

2-7.11 Other Analyses

The present level of design has been based on local standards for roadway design requirements, hydraulic analyses, loading requirements of structures, and constructability considerations.

2-7.12 Additional Studies, Tests, Analyses

The information needed to design a bridge is generally captured in the following studies, tests, and analyses:

- **Boundary and Topographic Survey**
- **Geotechnical Investigation and Report**
- **Hydrodynamic, Hydraulic, and Scour Analyses**

Additional investigation and studies may be needed for permitting or other site requirements unrelated to the infrastructure. See Section 2-21 for a complete list of recommended additional studies and investigations.

2-8 ELECTRICAL AND MECHANICAL REQUIREMENTS

Electrical and mechanical structure requirements are not applicable to this site.

2-9 HAZARDOUS AND TOXIC MATERIALS

A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments*, and ER 1165-2-132: *HTRW Guidance for Civil Works Projects*. The Phase 1 Environmental Site Assessment report is attached in Annex 2-1.

One recognized environmental condition exists at the Nooksack site. The Wilder hazardous landfill contains uncontrolled but currently non-migrating contamination. EPA identified that no action was necessary based on the fact that the contamination did not have a migration pathway. However, the proposed Corps project will extend the river adjacent to the site in areas that were not previously saturated.

One of these areas is Claypit Pond, located immediately west and down-gradient from the Wilder site. Claypit Pond has historically had elevated concentrations of contaminants in sediment, although no human health risk was identified. These contaminants were suspected to come from three sites to the east, including the Wilder location. It was suspected that surface water drainage through culverts was the mechanism by which contaminants moved into the pond.

As of today, there is no reason to believe that contaminants from these sites are flowing into the pond, due to low permeability of the surrouuding soils. However, inundation of Claypit Pond from the Corps project has a limited probability of changing the groundwater gradient, or more generally the overall hydrology, such that contaminants originating from the hazardous waste landfill could more easily flow into the pond (See Annex 2-1, Exhibit C). Therefore, the Corps project has the potential to be impacted by contamination. This potential risk is addressed in the PSNERP Nooksack Risk Register and in the Memorandum for Record dated 8 December 2015, located in the project file.

2-10 CONSTRUCTION PROCEDURES AND WATER CONTROL PLAN

The proposed restoration will involve earthwork and exposure of bare ground during modification of multiple dikes, removal and replacement of multiple bridges, and river channel rehabilitation. At this stage of design, it is assumed that standard best management practices will be implemented to control erosion and sedimentation and ensure construction areas are stabilized as needed to prevent adverse impacts. A standard temporary erosion and sediment control plan will be developed during PED.

The proposed restoration will also involve in-water work during removal and replacement of multiple bridges, conversion of tide gates, construction of an engineered diversion structure, river channel rehabilitation, and dike breaches. Most of the bridge work will be constructed above the ordinary high water mark. However, where bridge piers would be located in water, installation of caissons or coffer dams will be required prior to drilling of shafts to isolate the work zone. Removal of piles from existing bridges will require measures to contain sediment. The most appropriate methods will be selected during PED and will be coordinated with the natural resource agencies for environmental protection.

Other in-water work associated with dike breaches and rehabilitation of channels will be sequenced and timed to minimize exposure, and industry standard best management practices would be used. Specific measures of the in-water workplan will be determined during PED.

Specific measures for construction procedures and water control will vary depending on the location and nature of the work. State and Federal resource agencies will impose specific timing restrictions on in-water work to protect fish and wildlife. In addition, specific measures may be required under site-specific environmental compliance requirements and to protect downstream infrastructure or built environments. The erosion and water quality control plan will also need to consider and incorporate the findings of future analyses for hazardous and toxic materials at the site (as described in Section 2-9). A complete description of best management practices will be determined during PED.

2-11 INITIAL RESERVOIR FILLING AND SURVEILLANCE PLAN

The proposal is for ecosystem restoration. (Not applicable.)

2-12 FLOOD EMERGENCY PLANS FOR AREAS DOWNSTREAM OF CORPS DAMS

The proposal is for ecosystem restoration. (Not applicable.)

2-13 ENVIRONMENTAL OBJECTIVE AND REQUIREMENTS

Feasibility level information to develop designs, plans, and specifications, and to execute construction and operations is included in the Project's supporting documents including the U.S. Fish and Wildlife Service report titled "Strategic Restoration Conceptual Design - Preliminary Environmental Contaminant, Cultural Resource, and Endangered Species Site Evaluations." The environmental information developed for the analysis in the FR/EIS provides additional environmental objectives and requirements for final site design development. As summarized in Section 2-6, Civil Design, substantial environmental information was developed for the Final FR/EIS regarding environmental problems, opportunities, and constraints such that the Corps could estimate costs of the restoration sites and prepare the Real Estate Plan. The Corps will adhere to requirements stated in the Endangered Species Act consultation documents, Clean Water Act Section 401 certification, and other site-specific environmental compliance documents. The Corps has prepared a Programmatic Agreement (PA) for Section 106 of the National Historic Preservation Act compliance. As outlined in the PA, cultural resource investigations are necessary in the PED phase to determine if National Register eligible historic properties are located in the restoration project area prior to construction. The Monitoring and Adaptive Management Plan will be used to determine whether the site is meeting environmental objectives after construction.

2-14 RESERVOIR CLEARING

The proposal is for ecosystem restoration. (Not applicable.)

2-15 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R)

OMRR&R costs for the Nooksack Delta site are related to:

- Levee maintenance and levee repair equal to 900 lf sections spread over 1800 lf every 15 years.
- Vegetation costs such as site watering for plant establishment over the first 2-3 years prior to the start of adaptive management as well as costs to fight invasive vegetation assuming 53 acres of invasive species control per year for 10 years.
- Yearly culvert inspection and maintenance such as removal of debris and sediment.
- Roadway & embankment inspection, maintenance and repair - Maintenance costs for roadways and road bridges were developed based upon the WSDOT Pavement Policy. It is assumed that roadways will be constructed with hot-mix asphalt, and that the maintenance of a particular road will occur as part of a larger effort that includes adjacent road sections. Repair and maintenance includes:
    - Roadway asphalt overlay twice during the 50-year period of analysis
    - Roadway grind and inlay once during the 50-year period of analysis
    - Roadway guardrails, signs and striping
- Bridge maintenance - Bridges will be constructed using pre-stressed concrete girders which are commonly used due to their low maintenance costs. WSDOT staff indicated that the maintenance costs do not vary greatly by bridge length (Wilson, 2011 and Baroga, 2011). Maintenance activities will include:
    - Bridge inspection & cleaning every year 2 or 3 man crew for 1 week
    - Replacement of guardrails, retrofit and structural repairs
- Diversion structure maintenance, assuming excavation of 100 ft x 100 ft x 10 ft every 5 years.

Annual OMRR&R is estimated at $705,000 for the 50-year project period. Additional assessment of OMRR&R activities will be conducted during PED.

The proposed setback levees will be designed in accordance with applicable USACE engineering manuals. Operation and maintenance of these structures will be necessary to ensure proper functioning of the

structures and will be the responsibility of the local sponsor as detailed in the applicable O&M manual. Maintenance zones should extend 15 feet from both the riverward and landward setback levee toe. This maintenance zone should remain free of unwanted vegetation and unauthorized encroachments. Sod cover and riprap maintenance will be necessary to ensure proper functioning of erosion protection.

At the completion of the restoration project, an operation manual detailing proper maintenance practices for the setback levees will be provided to the local sponsor. Since the levees would be congressionally authorized and federally constructed, they will be ICW (Inspection of Completed Works) projects and automatically enrolled (eligible) in the PL 84-99 rehabilitation program.

2-15.1 33CFR Part 208 Projects

The proposed site is not a flood control project to be maintained and operated according to regulations in 33 CFR 208. (Not applicable.)

2-15.2 Channel or Basin Clean Out Projects

No channel or basin cleanout activities are proposed. (Not applicable.)

2-15.3 Multiple-Purpose, Complex Projects with Power Production

No power production is proposed. (Not applicable.)

2-15.1 Frequency and Cost of Maintenance Dredging

No maintenance dredging is proposed. (Not applicable.)

2-16 ACCESS ROADS

Access to the sites during construction can occur via the existing system of county and farm access roads. Earthwork activities will require heavy equipment to be mobilized to the sites. Temporary traffic control would be necessary during mobilization and fill removal activities. At least one route to the Lummi Peninsula will be maintained for traffic. Traffic can be staged to minimize road closures. Construction staging areas will be further analyzed during PED.

Permanent access will be required for maintenance of dikes.

2-17 CORROSION MITIGATION

Typical design standards use materials that are suitable for a marine environment such as concrete and galvanized steel pipe. Concrete was selected for the bridge superstructure and for the drilled shafts. If an alternate foundation system is selected, such as CIP steel piles, then galvanized steel should be used. Corrosion is generally not an issue for buried utilities or overhead power lines.

2-18 PROJECT SECURITY

The proposal is for ecosystem restoration. (Not applicable.)

2-19 COST ESTIMATES

The Nooksack River Delta construction cost estimate of $261,805,000 (March 2016 dollars) consists of costs to restore riverine and estuary areas and allow a return to more natural hydrology. This is the action with the highest total cost in the PSNERP project. Major features of work include work related to levee

setbacks, and road and bridge demolition and installation. Other minor work includes plantings, large woody debris installation, and channel excavation.

The largest cost driver is relocations including demolition of existing levees, bridges and roadways and construction of new roads, bridges and levees ($149,818,000 construction cost, March 2016 dollars). This work consists of demolishing an existing dike road, setting back the dike, temporary construction facilities and platforms used to construct the bridges.

Following a formal cost and schedule risks analysis, a project contingency of 40% was developed. Primary engineering related cost risks came from the high uncertainty surrounding bridge and bridge foundation design. Minimal detail was provided in the design report and additional geotechnical and survey information will be required to constrain the uncertainty in these costs. The primary schedule risk is from delays that could be experienced during removal of structures at the site.

Risks that do not directly affect cost include excessive sedimentation either at the flow diversion or in the Lummi River channel may lead to flow reduction or obstruction of the river. Further analysis is needed in this area, and requirements could range from a monitoring plan to omission from the project scope.

Opportunities for this site for cost come from the possibility that bridge work may be substantially less expensive than predicted. This chiefly comes from the standardized designs used throughout PSNERP for bridges. Foundation piers were all designed very conservatively, and may be reduced with additional analysis. Schedule opportunities come from the same issue. The PDT considered it likely that there could be schedule reductions from lowered requirements.

2-20 SCHEDULE FOR DESIGN AND CONSTRUCTION

The proposed restoration at the Nooksack River Delta is considered highly complex. Based on the level of complexity, the anticipated design period for the site is approximately 5 years. This includes preparation of final design, plans and specifications, and the construction contract.

This project involves many elements, including removal of levees, reconnection of channels, linear ditches, and modification of transportation infrastructure. The anticipated construction period for the project is approximately 4 to 6 years. Any in-water construction activities will take place during established work windows.

All aspects of construction would need to be carefully phased to avoid elevated flood risks and comply with in-water work windows. Notably, the setback levee system would need to be in place on both sides of the delta before: (1) levee removal on the mainstem, and (2) allowing additional flow to enter the Lummi River channel. Road and bridge elements would need to be phased in a manner that allows for continuous access to and from the Lummi Peninsula.

Property acquisition and permitting timelines are not included in this duration, but the time required to complete these upfront activities is expected to be substantial.

2-21 STUDIES TO BE COMPLETED IN PED

Table 2-21-1 summarizes recommended studies and additional investigations to be conducted to support subsequent stages of design and implementation. Unless otherwise noted, these studies are recommended to take place during PED. In the table, studies are classified according to the following purposes:

- Data required for design, cost estimation or project compliance,
- design analysis to minimize project construction costs,
- design analysis to optimize environmental benefits,
- identification of induced flooding,
- and identification of actions needed for O&M.

Table 2-21-1. Studies Recommended for the Nooksack River Delta Site

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Property Investigation/Survey	• Compile more detailed information on parcel ownership and property boundaries to finalize the design, confirm acquisition requirements, and support negotiations with property owners.	X	X			
Topographic/ Planimetric/ Bathymetric Survey	• Acquire site-specific topographic and bathymetric survey data to refine design of key project elements, develop detailed construction and demolition plans, and serve as a baseline for pre- and post-construction modeling, including hydrodynamic modeling.	X				
	• Install a temporary tide gage in the early design stages to obtain site-specific tidal statistics.	X				
Geomorphic Analysis	• Complete a geomorphic analysis of channel migration potential to consider channel response to dike setback and increased tidal influence and fine tune levee removal locations.		X	X		X
Hydraulic Analysis/Modeling	• Gather hydrologic data on freshwater flows and tidal levels at this site to support hydraulic and sediment studies. Establish the design hydrology of the Nooksack Delta.	X				
	• Develop criteria for minimum bridge clearances over water, Lnmmi River diversion design, Lummi River channel sizing, and large wood designs.		X	X		
	• Review the existing FEQ hydraulic model developed by Whatcom County and Lummi Nation (or other 2-D models). Conduct hydrodynamic modeling to investigate water surface elevations under pre and post project conditions. This investigation would ensure that significant high flow conveyances are accounted for, optimize levee setbacks and removals, and investigate upstream and downstream impacts to peak flood stages (e.g., Hovander Road, BNSF rail line). Evaluate the design of the facility and its potential effects on hydraulics and sedimentation.		X	X	X	X

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Hydraulic Analysis/Modeling (cont.)	• Combine review of aerial photographs with field surveys to quantify channel topology and hydraulic roughness and inform geomorphic evaluation under restored conditions.	X				
	• Use numerical modeling and physical modeling if needed, to complete design and operation plans for the flow control structure at the junction of the Lummi and Nooksack Rivers. Evaluate the need for an energy dissipation facility in conjunction with conveying flow from the Nooksack River to the Lummi River.		X			
	• Complete water quality sampling and analysis of water quality effects as needed.			X		
	• Review the potential effects on water wells, septic systems, and groundwater seepage in the area of potential hydraulic effect to inform project design.		X			
	• Formulate the detailed monitoring plan, including any required field surveys or iustrumentation that will be used to evaluate the project's hydraulic performance.			X		X
Sedimentation Analysis/Modeling	• Conduct sediment transport evaluations to decrease uncertainty about floodplain sedimentation processes and sustainability. Address the amount and potential areas of sedimentation in channels and at levees. This will require a sediment transport model.		X	X	X	X
	• Evaluate the effects of changes in sedimentation patterns in the Nooksack River downstream of the junction with the Lummi River.		X	X		X
	• Evaluate the need for slope protection on levees, roadway embankments, and bridge abutments and address the issne of bridge scour at piers and abutments.		X			
Coastal Engineering Studies	• Refine sea level projections using localized tide gauge data.	X				
	• Review and establish the final design tidal datums		X			
	• Conduct wind direction and wave run-up analysis to inform levee and bridge design.		X	X	X	

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Geotechnical Investigation	• Complete a standard investigation to include subsurface explorations, testing, and field reconnaissance.	X	X			
	• Confirm borrow and disposal sites.	X	X			
	• Complete additional geotechnical study and recommendations to finalize design of levees, roads, and bridges.		X			
	• Perform a settlement analysis for roadway embankments.		X			
	• Complete stability, settlement, and seepage analysis for levee design.		X		X	X
Foundation Design Study	• Perform static and seismic analysis according to WSDOT/AASHTO LRFD for vehicle bridges.		X			
Abutment Stability Study	• Evaluate the potential for liquefaction and ground improvement.		X			
Excavated Materials Study	• Evaluate the suitability of excavated materials for reuse.	X	X			
Pavement Design Study	• Complete a pavement design study for new roadways and approaches (include traffic analysis for ESALs).		X			
Structural Engineering	• Structural analysis of the bridge, bridge piers, and foundation.		X			
	• Analysis for gravity, wind and seismic effects.		X			
	• Design of bridge deck and supporting structure for gravity, wind and seismic effects in accordance with criteria established in this report.		X			
Utility Survey	• Compile more detailed information on utilities to finalize the design and confirm acquisition requirements.	X	X			
Cultural Resources Investigation	• Complete surveys for archaeological and historic resources, particularly in areas proposed for excavation.	X	X	X		
Wetlands Investigation	• Document the location, extent, and character of wetlands.	X		X		

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Cost Study	• Assess potential for cost and schedule reductions during refinement of restoration design.		X			
Environmental Compliance	• The Corps will coordinate with all relevant natural resource agencies during PED. Results of PED-phase studies will be provided to agencies and tribes as appropriate.			X		

2-22 DATA MANAGEMENT

Project documents, background materials, and digital files from the local sponsors were provided to the project team directly, through the State's Habitat Work Schedule, or via the Nearshore Sharepoint. The project team also used databases previously developed by and for the Nearshore Ecosystem Restoration Project including the Change Analysis and backing geospatial data (see Section 2-3.1.1 for additional detail).

Work products for the conceptual restoration designs were developed primarily in GIS and typical word processor and spreadsheet applications. GIS products for all sites were collected in a single geodatabase that captured spatially referenced locations and sizes of major design elements. GIS data resides in two locations: the Corps' Seattle District office, and at the University of Washington where staff used the data to assist with development of the Ecosystem Benefits Model.

2-23 USE OF METRIC SYSTEM MEASUREMENTS

This report uses United States customary units for design and construction measurements. To remain consistent with work conducted to date, the metric system of measurement was not used.

2-24 REFERENCES

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ANNEX 2-1: EXHIBITS

This annex contains a set of site-specific exhibits prepared for the proposed restoration. The exhibits include:

Exhibit A – Design Plan

Exhibit B – Design Sections

Exhibit C – Phase 1 Environmental Site Assessment

Exhibit A

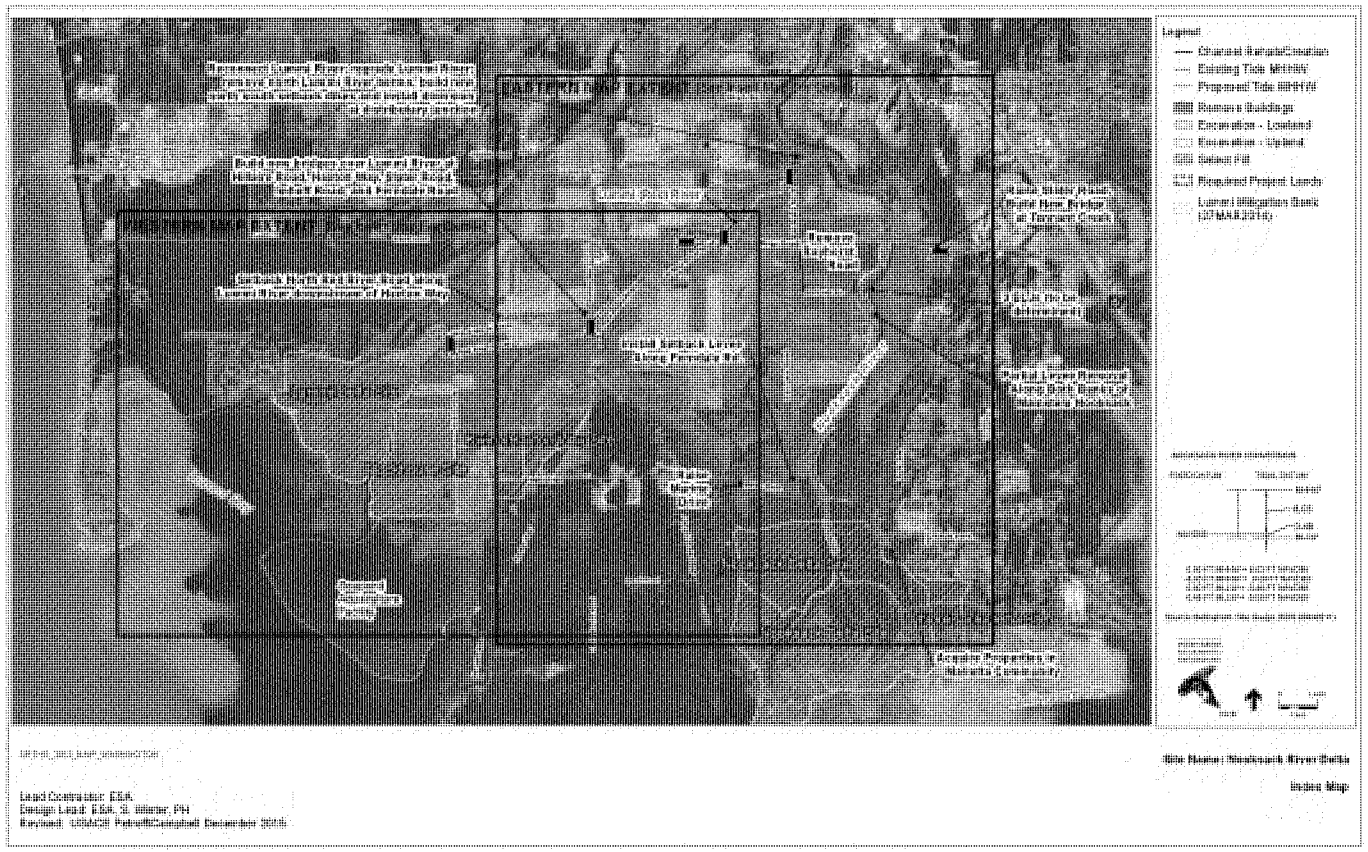
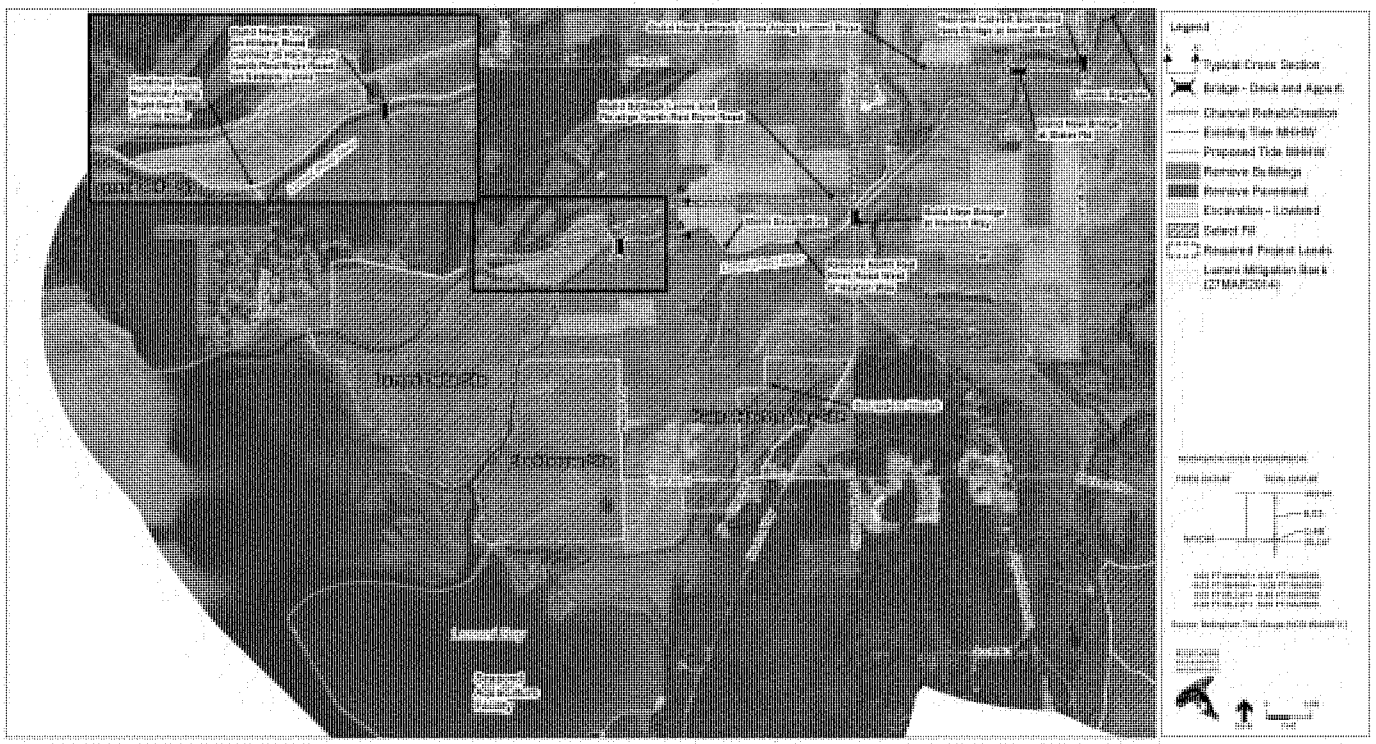


Exhibit A



Site Name: Nooksack River Delta

West View

Lead Contractor: ESA
Design Lead: ESA, S. Winter, PH
Revised: USACE Petroff/Campbell December 2015

Exhibit A

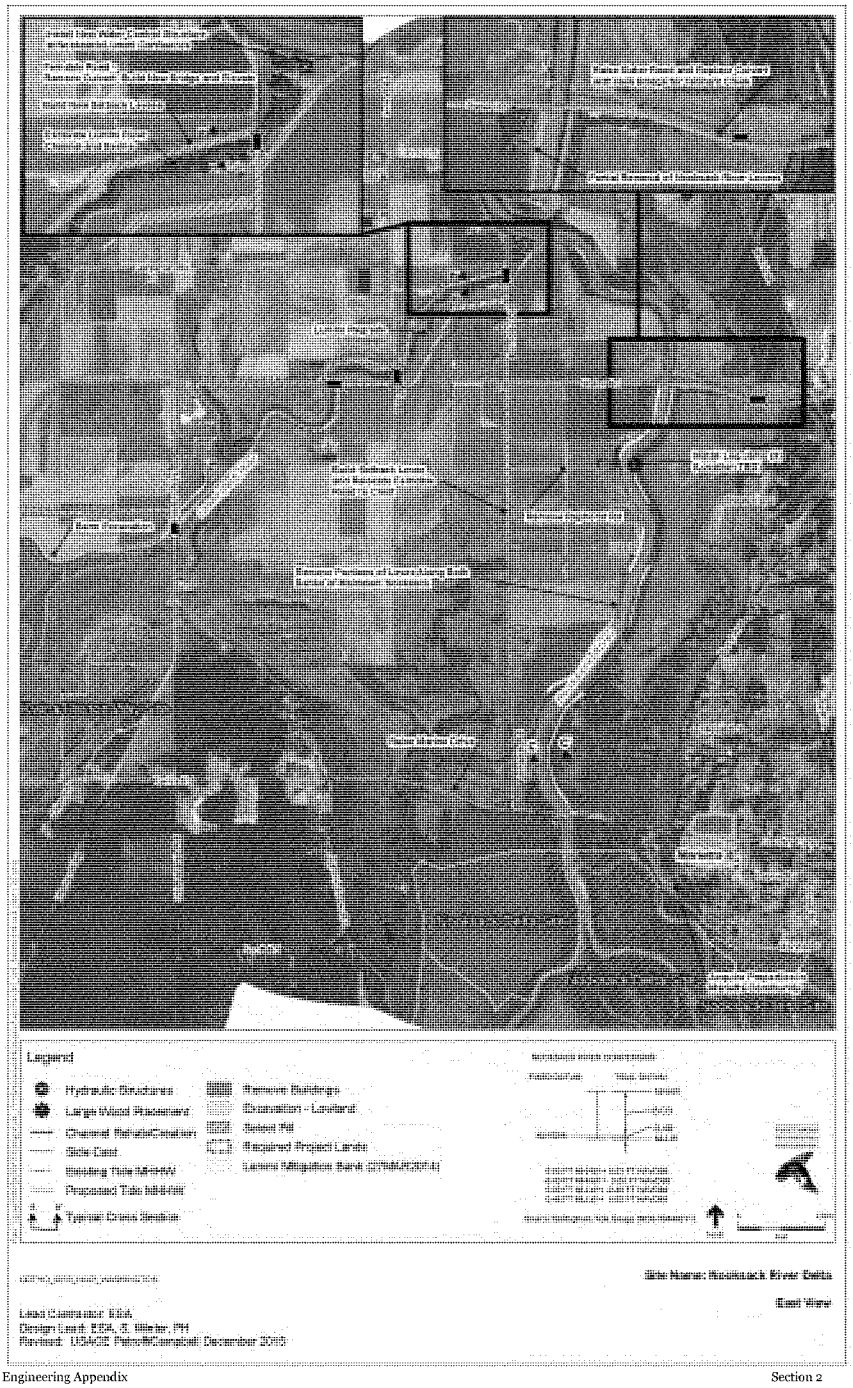
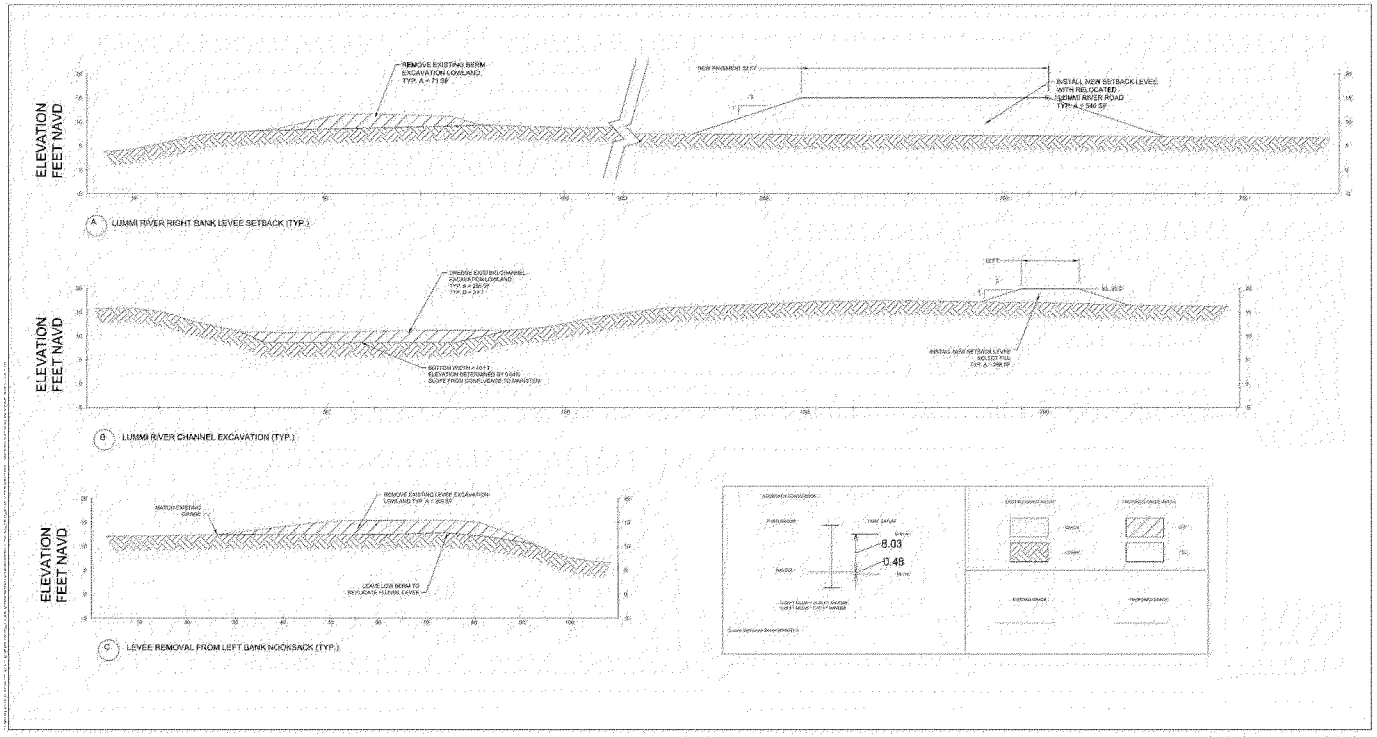

Legend
Hydraulic Structures
Large Wood Placement
Channel Rehab/Creation
Side Cast
Existing Tide MHHW
Proposed Tide MHHW
Typical Cross Section
Remove Buildings
Excavation - Lowland
Select Fill
Required Project Lands
Site Name: Nooksack River Delta
East View
Lead Contractor: ESA
Design Lead: ESA, S. Winter, PH
Revised: USACE Patch/Compiled: December 2015

Exhibit B

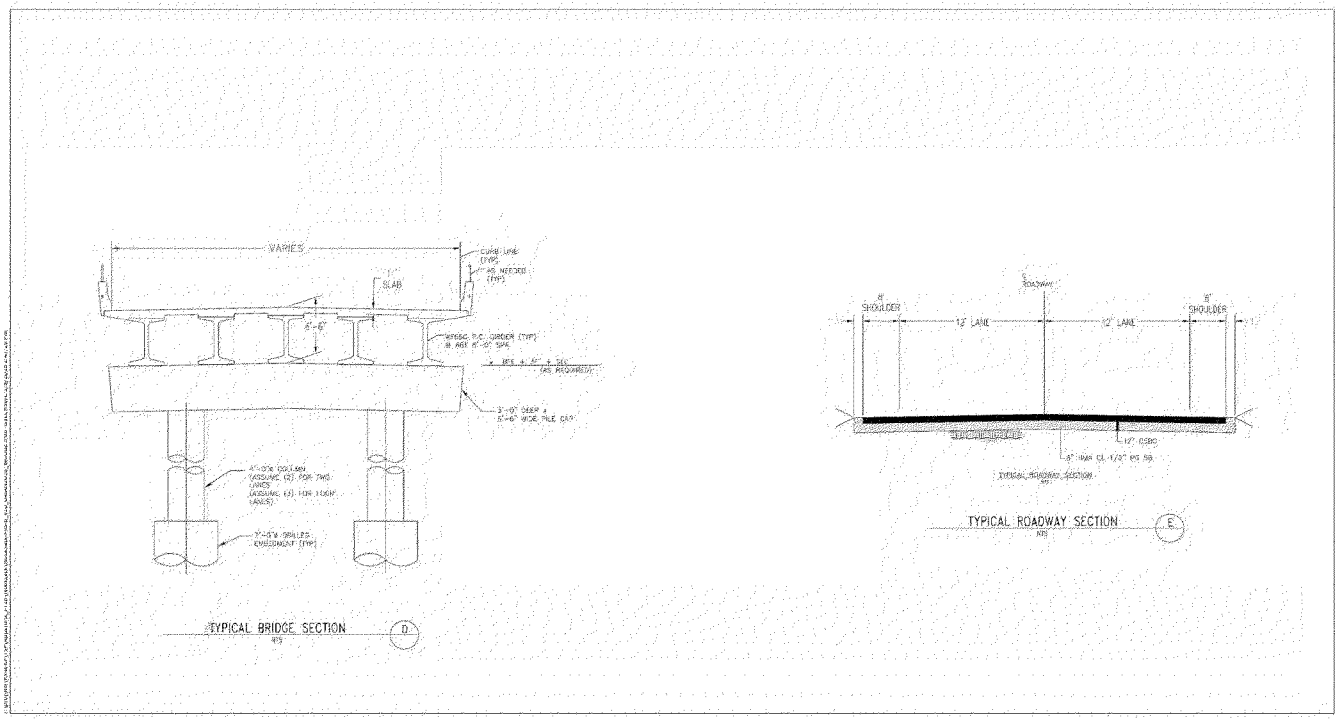


ORTHO_2013_NAIP_WASHINGTON

Site Name: Nooksack River Delta

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sasseri, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit B



ORTHO_2013_NAIP_WASHINGTON

Site Name: Nooksack River Delta

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit C

Puget Sound Nearshore Ecosystem Restoration Project
Feasibility Study
Hazardous, Toxic, and Radioactive Waste
Phase 1 Environmental Site Assessment

EXECUTIVE SUMMARY

The Seattle District Corps of Engineers (Corps), working collaboratively with the Washington Department of Fish and Wildlife (WDFW) as local sponsor, along with many other regional partners, has conducted a General Investigation (GI) to evaluate problems and potential solutions of ecosystem degradation and habitat loss in Puget Sound, Washington. The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). The Corps and local sponsor are recommending implementation of restoration actions at three sites throughout the study area as the outcome of the Nearshore Study. Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, the U.S. Army Corps of Engineers is preparing an Integrated Feasibility Report/Environmental Impact Statement (FR/EIS) for the three restoration actions. The Phase 1 Environmental Site Assessment for the Nooksack River site is being conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects,* except where noted below.

The assessment revealed several recognized environmental conditions in connection with areas adjacent to the project footprint, although all but one of these sites have no potential to impact the proposed project. The one exception is the Wilder Hazardous Waste Landfill site, located approximately a half mile east of the project footprint. There was determined to be a small risk of contaminants in the landfill being mobilized by flooding as a result of the proposed project. This risk is fully detailed in the Nooksack Risk Register, and in the project file Memorandum For Record dated 8 December 2015. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of current and potential HTRW sites in connection with a property within reasonable limits of time and cost.

Exhibit C

Puget Sound Nearshore Ecosystem Restoration Project
Feasibility Study
Hazardous, Toxic, and Radioactive Waste
Phase 1 Environmental Site Assessment

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1.0 INTRODUCTION

1.1 Involved Parties

The Corps is the lead Federal agency for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Report. The non-Federal, cost-sharing sponsor is the Washington Department of Fish and Wildlife (WDFW). As the non-Federal sponsor, WDFW contributes 50 percent of the total feasibility study costs in the form of cash or in-kind contributions; a feasibility cost sharing agreement was executed in 2001, with amendments.

1.2 Authority

The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874).

1.3 Guidance and Policy

Corps policy providing guidance for consideration of issues and problems associated with hazardous, toxic, and radioactive wastes (HTRW), as defined in this regulation, which may be located within project boundaries or may affect or be affected by Corps Civil Works projects is contained in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects*, which defines HTRW as "...any material listed as a 'hazardous substance' under the Comprehensive Environmental Response, Compensation, Liability Act (CERCLA)". ASTM International (ASTM) Standard E 1527-13 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* provides a comprehensive guide for conducting an HTRW Assessment. An assessment identifies known or suspected releases of hazardous substances (recognized environmental conditions) based on records review, site visit, and interviews.

1.4 Scope of Work

The complete investigation serves to identify any recognized environmental condition, as defined in ASTM Standard E 1527-13. This site assessment documents known and suspected HTRW sites discovered through a search and review of all reasonably attainable federal, state, and local government information and records. A site visit, interviews with relevant stakeholders, and review of aerial photographs are also mandated under the above standard.

1.5 Significant Assumptions

This report identifies known and suspected environmental concerns, both past and present based on availability of information at the time of the assessment. It is possible that unreported disposal of waste or illegal activities impairing the environmental status of the properties may have occurred which could not be identified.

1.6 Limitations and Exceptions

This document deviates slightly from the exact procedures outlined in ASTM E1527-13. Specifically, no "User Provided Information" nor "Non-Scope Services" were provided, and those sections of the report were omitted. Also, due to the layout of the overall document to which this report will be incorporated, it was decided that no appendices were to be generated for this report. Additionally, it should be noted that portions of this report were conducted by separate agency entities that did not have the ability to coordinate their efforts. However, this does not change the results or outcome of the report.

1.7 Special Terms and Conditions

No special terms or conditions with respect to ER 1165-2-132 and ASTM E 1527-13 standards were made.

Exhibit C

1.8 User Reliance

In accordance with ASTM E 1527-13 Section 7.5.2.1 "Reliance," the environmental professional is not required to independently verify the information provided by various sources but may rely on the information unless there is actual knowledge that certain information is incorrect or unless it is obvious that certain information is incorrect based on other information obtained during the course of the investigation or otherwise actually known to the investigators conducting the assessment. At the present time there is no indication that the information provided by the database search is incorrect.

2.0 SITE DESCRIPTION

2.1 Location and Legal Description

The "property", as defined by the referenced ASTM standard, in this case includes several different properties within the Nooksack River valley. For the purposes of this assessment, the proposed Nooksack project footprint will serve as the "property" under review (See Figure 6-2 in the main body text).

2.2 Site and Vicinity General Characteristics

The physical setting of the subject property and vicinity is detailed in Section 4.6.4.5 of the main feasibility report.

3.0 RECORDS REVIEW

3.1 Standard Environmental Records

A records search was conducted on October 16, 2015 using a variety of sources, including EPA's National Priority List Mapper, EPA's EnviroFacts database, the Washington State Department of Ecology's (Ecology) Toxics Cleanup Program (TCP) database, and Ecology's Facility/Site database. Below are the parameters and results of the records search.

Parameter	Source	Minimum Search Distance (mi.)	Results
Federal NPL	EPA NPL Mapper	1	None
Federal Delisted NPL	EPA NPL Mapper	0.5	None
Federal CERCLIS	EnviroFacts	0.5	None
Federal RCRA Generators	EnviroFacts	Property and Adjoining Properties Only	None
Federal RCRA TSDs	EnviroFacts	0.5	None
Federal RCRA Corrective Action Sites	EnviroFacts	1	None
Federal and State ICs Registry	Ecology TCP	Property Only	None
Federal Toxic Release Inventory	EnviroFacts	0.5	None

Exhibit C

Parameter	Source	Minimum Search Distance (mi.)	Results
State and Tribal Cleanup Sites	Ecology TCP	1	5 findings (see below)
State and Tribal Landfills and/or Solid Waste Disposal Facilities	Ecology Facility Search	0.5	None
State and Tribal UST Registry	Ecology TCP	Property and Adjoining Properties Only	None
State and Tribal LUST	Ecology TCP	0.5	1 finding (Friese Hide & Tallow)
State and Tribal Brownfields	Ecology TCP	0.5	Noue

The records search identified 5 state cleanup sites and 1 leaking underground storage tank within the applicable search distances. The records search also identified several other sites that, despite not being within the search radius, are worth discussion. Each of these sites will be discussed below.

Of the identified cleanup sites, only one is located within the project footprint, known as the Mount Property. This property is located at the eastern end of Rayhorst Road, 100 to 200 feet from the Nooksack River. In 2003, eight 55 gallon barrels of used motor oil were reported to Whatcom County as leaking into the ground on the property. Upon coutact from the County, the owner disposed of the drums, excavated the contaminated soil, and stockpiled the soil onsite for eventual removal. The property was sold as-is in 2005, and the soil pile was not observed. However, the site cannot be verified as cleaned up by Ecology due to the lack of documentation. For the purposes of the proposed Corps project however, this site does not pose a risk despite its continued placement on the state cleanup list.

The leaking underground storage tank identified in the record search triggered a cleanup action at a site known as Friese Hide and Tallow, located immediately north of 1524 Slater Road. The company that owns the property conducts cattle hide curing for eventual shipment overseas. The hides are cured using only salt, with no other chemicals. Ecology conducted a preliminary assessment (PA) in 1989 verifying this claim, and further determined that the salt runoff was not in such quantities as to warrant further consideration by the agency. However, Ecology received several reports of leaking underground storage tanks between 1991 and 1992. Two USTs were subsequently removed voluntarily in 1991. No closure or removal report was filed until 2010, when the owner conducted a site assessment (SA), finding residual petroleum contamination. The contractor determined that the contamination had not migrated to groundwater, and did not appear to be migrating at all. However, as a result the residual contamination and the lack of proper UST closure documentation, Ecology is currently planning to conduct its own SA in order to close the site for good. Given the initial findings of the 2010 SA, and the fact that Ecology is planning their own investigation, it is determined that this site will not impact the proposed Corps project, and no further investigation is needed.

Two of the three remaining cleanup sites identified in the record search actually refer to the same site. The Recomp of Washington site (also known as the Thermal Reduction Landfill) is located at 1524 Slater Road, and was a permitted municipal scale solid waste handler from 1974 to 1989. The site had a solid waste incinerator and an onsite landfill where the resultant ash and other wastes were placed. The incinerator and landfill were closed in 1989 following a series of County violations, and the landfill was graded, covered in low permeability clay, and covered by an HDPE liner. A leachate collection system was

Exhibit C

installed downgradient from the closed landfill, and was connected to a POTW. Groundwater and leachate monitoring was initiated in 1988 and continued until 2001, with no exceedences of applicable standards. In 2004, Ecology stated that there was no further action (NFA) needed, and a restrictive covenant was filed for the property to preclude future ground disturbance. Ecology conducted a periodic review in 2011 and identified no emerging problems. As a result, this site will not impact the proposed Corps action.

The final identified cleanup site is known as the Wilder hazardous waste landfill. Originally part of the Recomp of Washington landfill, this site is located immediately north of the Recomp site and east of Friese Hide and Tallow. The Recomp landfill began accepting and placing hazardous waste in this area starting in 1976-77, and operated until 1979, when it was closed for County compliance violations. During that span, this section of the landfill accepted over 1000 oil/resin drums, solvents, asbestos, insecticide, lignosite, incinerator ash from the Recomp incinerator, and pentachlorophenol. This portion of the landfill was covered in 3-4 ft. of ash and 5 ft. of dirt when it was closed in 1979. Since then there have been very few investigations on the hazardous waste area, besides a 1991 NFA determination from Ecology and a 2003 EPA PA. The 2003 assessment/investigation concluded that the hazardous waste source was not controlled, although due to the relative impermeability of the surrounding soils, contamination does not appear to be migrating. EPA went on to say that the surface water pathway appeared to be the most significant migration pathway, and since contaminants were not actively migrating in any pathways, EPA would take no further action.

Despite this determination by EPA, the Wilder hazardous waste landfill has the potential to impact the proposed Corps project. The Corps is proposing to essentially extend the Nooksack floodplain by the removal of levees on the river. This will cause areas to be flooded that were not previously impacted. One of these areas is Claypit Pond, located immediately west and downgradient from the Recomp, Friese Hide and Tallow, and Wilder sites discussed above. Claypit Pond, also known as Brennan Pond, has historically had elevated coucentrations of contaminants in sediment, although these concentrations were never so elevated as to pose a risk to human health. These contaminants were suspected to come from three sites to the east. It was suspected that surface water drainage through culverts was the mechanism by which these contaminants moved into the pond.

As of today, there is no reason to believe that contaminants form these sites are flowing into the pond, either because the source is controlled (Recomp, Friese Hide and Tallow) or because the surrounding soils have low permeability (Wilder). However, there is a possibility that inundating Claypit Pond will change the groundwater gradient, or more generally the overall hydrology, such that contaminants originating from the hazardous waste landfill will more easily flow into the pond. Therefore the Corps project would be impacted by contamination from one or more of the identified sites. This potential risk is addressed in the PSNERP Nooksack Risk Register and in the Memorandum for Record dated 8 December 2015.

The final site identified during the record search is known as the Lummi Shore Dump. Although this site was not identified within the search distance parameters, its alleged location prompted further investigation. Ecology landfill records indicate the existence of former landfill on Lummi reservation land, immediately east of the intersection of Lummi Shore Road and Scott Road, less than a mile from the Nooksack River, in the floodplain. An official Lummi Nation document states that the landfill operated from 1961 to 1972, and accepted household waste from tribal and nontribal sources. Ecology records indicate that EPA assessed the property under CERCLA in 1986 and determined "No further action". That same year, Ecology declined to assess the property, citing Federal authority and the EPA determination. No records of this site exists at EPA, and there does not appear to have been any action taken since 1986. Additionally, a review of aerial photographs from 1998 to the present show no obvious locations for a landfill, although there is a small structure and small pond east of the intersection that are possible candidates. Given the lack of specific information concerning the landfill's location, the lack of obvious significant ground disturbance in the area, the ¾ of a mile from the river, and the lack of specific proposed Corps action on that stretch of the river, the suspected site is not expected to impact the Corps project.

Exhibit C

Figure 1: HTRW Records Search Results

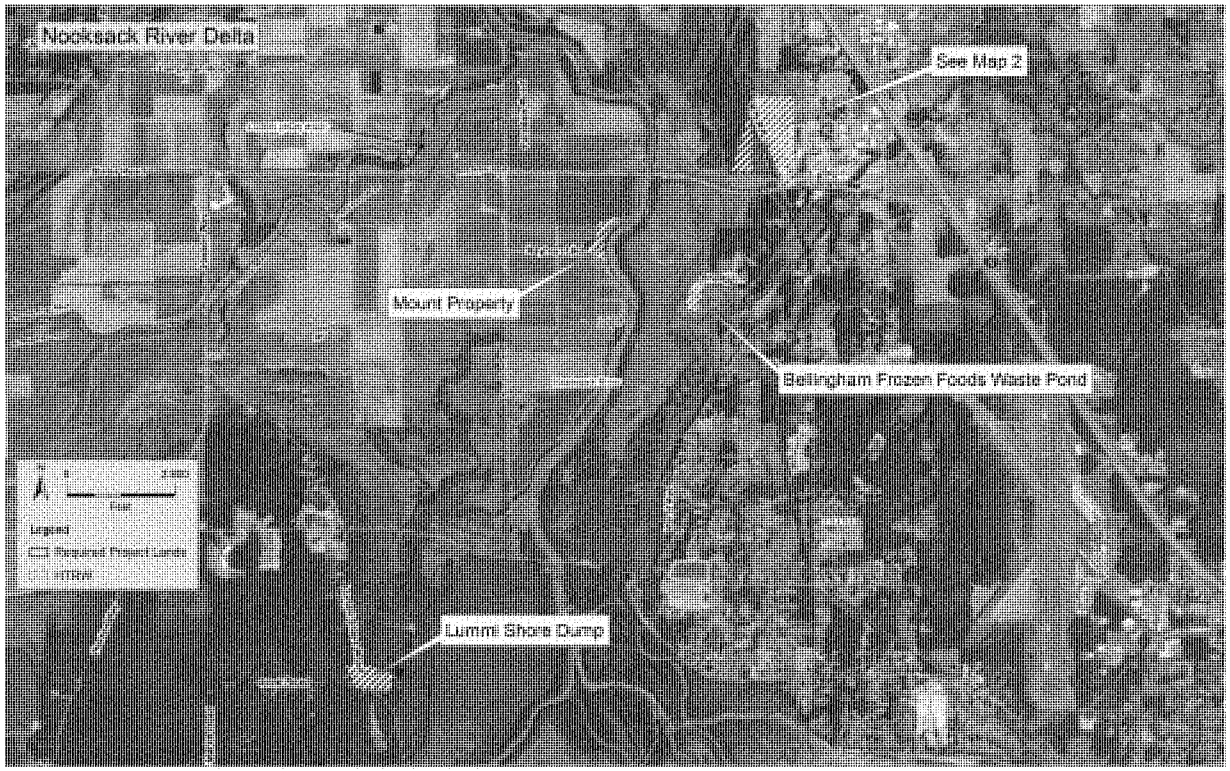
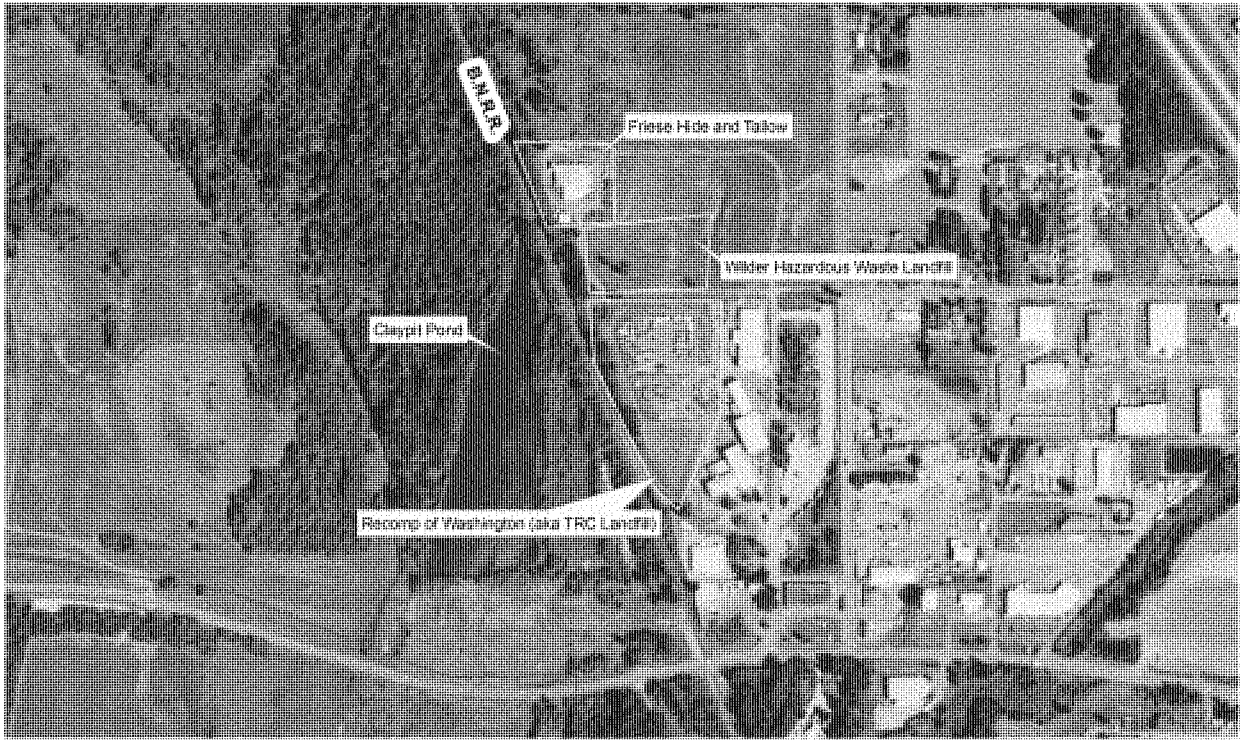


Exhibit C

Figure 2: HTRW Sites at 1524 Slater Road and Vicinity



3.2 Historical Records

A review of aerial photographs starting in 1963 to present land that is almost completely agricultural, with a small number of residences interspersed throughout. The only intensive changes within the project footprint are immediately east of the Nooksack River south of Slater Road. The aerial photographs from 1997 seem to indicate some sort of agricultural activity differing from the surrounding area; there were six circular green areas with several small buildings, as well as a small (approx. 4 acre) rectangular lagoon. Further investigation indicated that this was the Bellingham Frozen Foods Wastewater Treatment Facility. Wastewater is generated at a frozen vegetable plant in Bellingham, pumped into the rectangular lagoon to be treated, then sprayed into the six circular spray fields. The facility was purchased by the Washington State Department of Fish and Wildlife (WDFW) in 1998, and the spray fields were decommissioned. An environmental assessment was completed concerning the waste lagoon in 2003, and revealed no concerns. As a result, this site will not impact the proposed Corps project.

Numerous dairy farms were noted both in and around the project footprint during both the records search and aerial photograph review. Many of these facilities have National Pollutant Discharge Elimination System (NPDES) permits, and feature waste ponds related to the dairy. One facility, the Frank Moser Dairy, has a documented violation of this NPDES permit. While these discharges and waste ponds are not releases per the ASTM E1527-13 standard, it should be noted that the contents of these waste ponds may be unknown, and could be impacted in the case of inundation as a result of levee removal.

3.3 Additional Environmental Record Sources

There are no additional environmental record sources included in this assessment.

4.0 SITE RECONNAISSANCE

A site visit was conducted by the USFWS on February 1, 2011. The action area is currently owned by multiple landowners, and used primarily for agricultural purposes. There is potential for chemical or solvent storage at some of these sites, machinery and equipment repair areas, above ground storage tanks, older structures that may contain asbestos or lead. A visual survey of the action area revealed no known or suspected contaminant releases or spills. However, the Phase I site visit did not visit all parts of the action area, due to private property restrictions.

An interview was conducted in person by the USFWS on February 1, 2011 with Jeremy Freimund of the Lummi Nation, and Steve Seymour with WDFW. Telephone interviews were conducted by the USFWS with Carol Dorn and Gayle Garbush of Ecology, and Kye Iris with WDFW. No records of these interviews exist.

5.0 FINDINGS AND CONCLUSION

This Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects*. The assessment was initially conducted in 2011 by Cindy Schexnider, Specialist with the USFWS, and updated in 2015 by David Clark, remediation biologist at the Corps.

The assessment revealed several recognized environmental conditions in connection with areas adjacent to the project footprint, although all but one of these sites have no potential to impact the proposed project. The one exception is the Wilder Hazardous Waste Landfill site, located approximately a half mile east of the project footprint. There was determined to be a small risk of contaminants in the landfill being mobilized by flooding as a result of the proposed project. This risk is fully detailed in the Nooksack Risk Register, and in the project file Memorandum For Record dated 8 December 2015.

6.0 SOURCES

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Section 3 – North Fork Skagit River Delta

Section 3: North Fork Skagit River Delta

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3-1 GENERAL – NORTH FORK SKAGIT RIVER DELTA

3-1.1 Overview of Restoration Site

The North Fork of the Skagit River empties into Skagit Bay just south of the town of La Conner. The proposed action is located between the former inlet of Dry Slough and the western terminus of the dike system near Rawlins Road. Extensive diking of the North Fork Skagit River has caused substantial loss of tidally influenced wetlands and their associated tidal channels. River levees have disconnected the river from its floodplain, eliminated off-channel habitats, reduced floodplain area, and constrained the river channel.

The North Fork Skagit site was selected to address River Delta restoration objectives to protect and restore freshwater input and tidal processes where major river floodplains meet marine waters. Target ecosystem processes include:

- Tidal flow
- Freshwater input (including alluvial sediment delivery)
- Erosion and accretion of sediments
- Distributary channel migration
- Tidal channel formation and maintenance
- Detritus recruitment and retention
- Exchange of aquatic organisms

The proposed restoration would remove or set back flood risk management dikes on both sides of the river, restore natural levees, and restore 256 acres of rare tidal freshwater marsh. Key restoration elements of this action include the following:

- Lower and breach dikes; construct new dikes to maintain existing level of flood risk management
- Excavate tidal channel network
- Remove shore armor, buildings, pavement, boat ramp, and roads

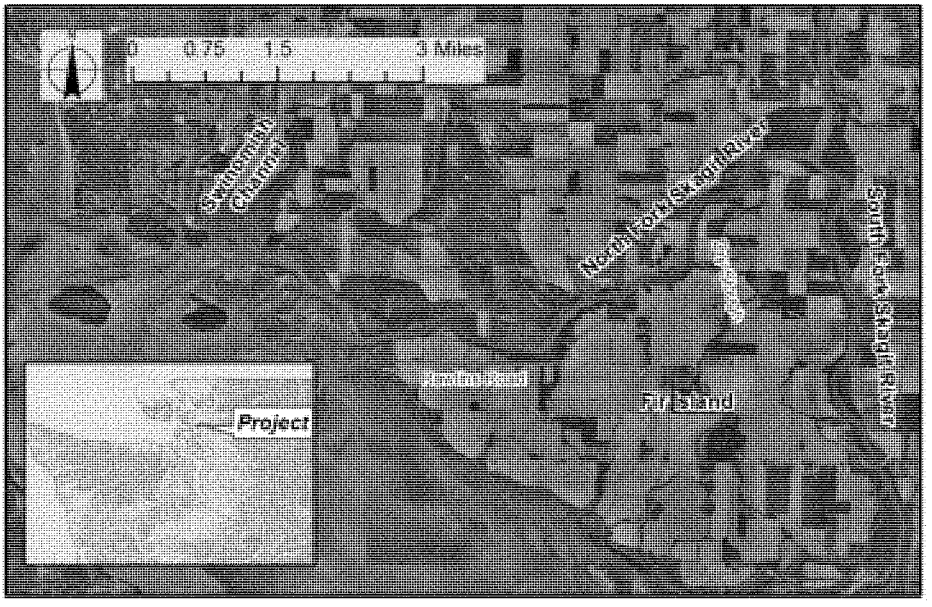

Figure 3-1-1. North Fork Skagit River and vicinity.

3-2 HYDROLOGY AND HYDRAULICS

The North Fork site lies in the estuary of the North Fork of the Skagit River. The Skagit River drains a watershed of over 2,700 square miles and splits into North and South Fork distributary channels about 10 miles upstream of the river mouths. The Skagit River downstream from Mount Vernon is fully confined by levees on both banks. The North and South Forks are similarly confined until they approach Skagit Bay maintaining a stable split in discharge. Both forks have aggraded similarly since observation in the 1970s. The North Fork Skagit River carries about 60 % of the flow at low flows. At high flows the split between the two forks is about 50/50. Average annual precipitation for this watershed is 101 inches per year. The site is located on the left bank of the North Fork Skagit River. Figure 3-2-1 shows a map of the watershed, including the North Fork of the Skagit River and the local drainages that affect The North Fork site.

The majority of the North Fork Skagit River Delta site lies below the 100-year flood elevation. The area is primarily agricultural. Blake's Resort, a small recreational vehicle (RV) park and dock, lies within the site adjacent to the left bank of the North Fork Skagit River. Highway 534, known as Best Road, crosses near the middle of the site and is a primary access to Fir Island, connecting it to Interstate 5 and State Route 20. The Best Road Bridge and its approaches are above the 100-year floodplain.

The intent of the project is to increase the frequency of both tidal flow and riverine flooding into the site for the purpose of habitat restoration. This will require removal of all structures and utilities within the project area. The project will lower the existing left bank levee and portions of the right bank shore armor, create a tidal channel network and build a setback levee on the left bank adjacent to Rawlins Road.

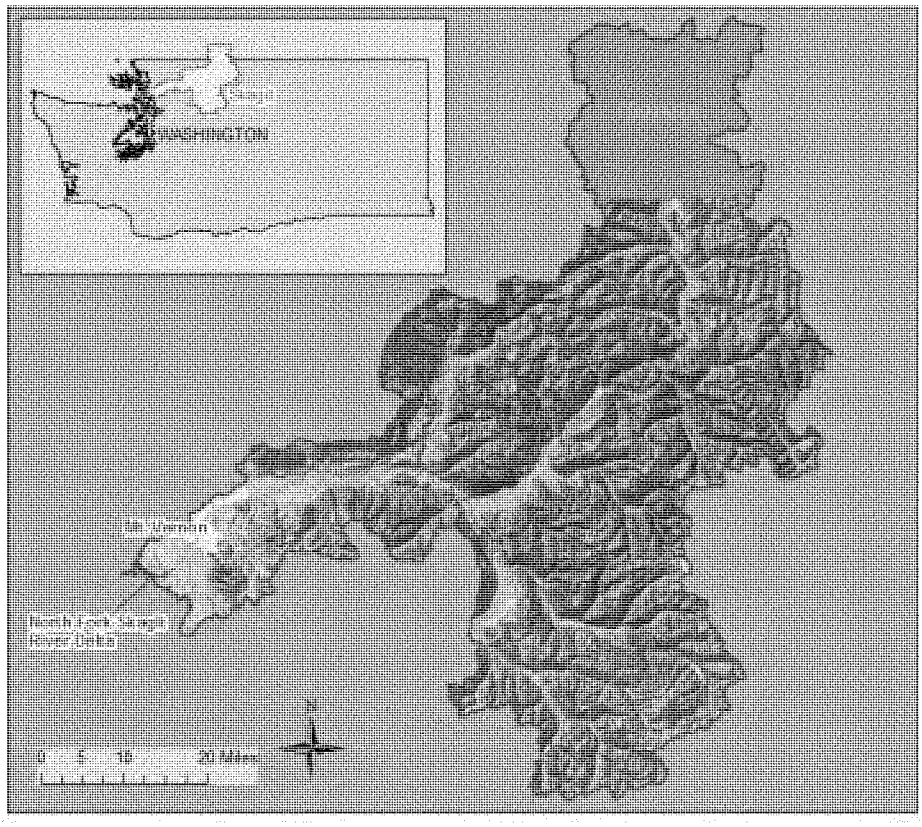

Figure 3-2-1. The North Fork Skagit River Delta site – Skagit River watershed.

The hydraulics and hydrology for all restoration sites in the Puget Sound Nearshore Ecosystem Restoration Project were evaluated using an area of potential hydraulic effects specific to the construction requirements for each particular site. The limits of the area for this site were established using 100-year Base Flood Elevations (BFEs) derived from a combination of Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps and Flood Insurance Studies as well as U.S. Army Corps of Engineers (USACE) BFE determinations.

According to the 1% Annual Exceedance Probability (100-year) BFE as determined by the FEMA flood insurance mapping for unincorporated areas of Skagit County, community 530151 (revised 1985), the entire site lies well within the 100-year floodplain and away from floodplain boundaries. Figure 3-2-2 shows the area of potential hydraulic effects for the North Fork site as identical with the restoration site boundaries. The FEMA BFE varies between 21 feet (NAVD88) at the upstream limit of the site and 12 feet (NAVD88) downstream and depends primarily on flooding from the Skagit River. Although the river is tidally influenced in this reach, the coastal BFE of 12.2 feet (NAVD88) is lower than the elevations from river flooding for all but the most downstream 2000 feet of the leveed area.

This delineation of the area of potential hydraulic effects assumes that the planned lowering and setting back of levees will not substantially adversely affect levees or infrastructure on adjacent properties. There is expected to be some slight lowering of flood levels in the vicinity of the site because of the levee setback.

In addition, there may some short term changes in sedimentation patterns downstream of the site as the river adjusts to the expanded cross-section. During Project Engineering and Design (PED), the current one-dimensional hydrodynamic (HECRAS) model of the Skagit River developed as part of the Skagit River General Investigation will be updated to reflect with and without project geometry and to confirm the extent of hydraulic effects from the restoration. Additional modeling during PED will include consideration of tidal influences. A three-dimensional estuarine and coastal ocean model, developed at the Pacific Northwest National Laboratory (PNNL) with support from the Skagit Watershed Council and the Skagit River System Corporative, has been successfully used to model and evaluate restoration projects in the Skagit watershed and is available to use during the project design phase (Yang and Khangaonkar, 2006).

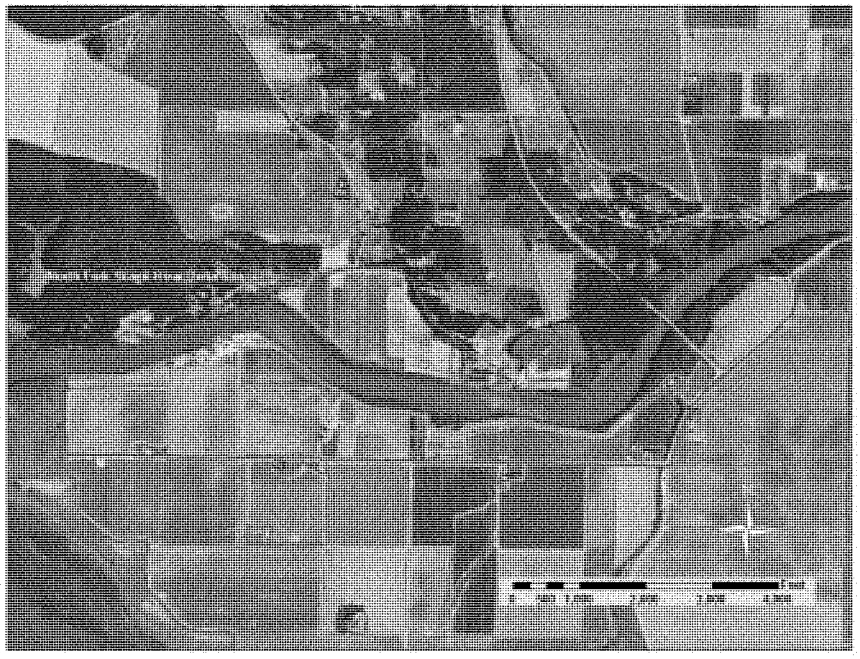

Figure 3-2-2. The North Fork Skagit River Delta: Area of potential hydraulic effects.

The Ecosystem Output Model (EOM), described in Appendix G utilized an area of restored process determined as follows:

The upland portion of each analysis area was delineated to ensure that the area included all stressor distributions within defined buffer distances from the shoreline. In the aquatic areas, the shape of the Analysis Area was determined by a combination of:

- The GIS area provided initially by the design team and the associated parcel map for the proposed action
- Ensuring an area encompassed all delineated tidal wetlands
- For any Analysis Area that extended through an aquatic area, boundaries were established approximately perpendicular to the shoreline orientation where the upland meets the shoreline.

The area of restored process at North Fork Skagit is shown in Figure 3-2-3 as 256 acres. For more information, please refer to Puget Sound Nearshore Ecosystem Restoration Project Fish and Wildlife Coordination Act Section 2(b) report in Appendix J, Environmental Compliance Documentation.

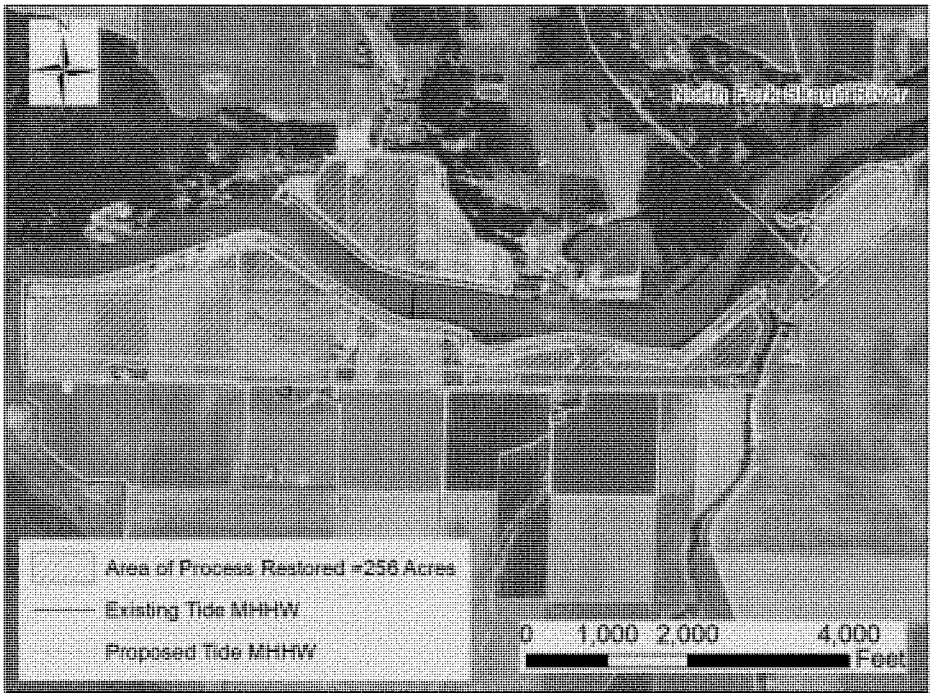

Figure 3-2-3. Area of process restored used in ecosystem output model at the North Fork Skagit River Delta.

3-2.1 Functional Design Requirements

This section describes the hydrologic and hydraulic setting for the site and the intended hydraulic consequences of the design features.

3-2.1.1 Consequences of flows exceeding discharge capacity of the project

The proposed action will restore the riverine floodplain and tidal connectivity along the lower reach of the North Fork of the Skagit River. This will require re-constructing a flood risk management levee further inland. The existing levee would be lowered and selectively breached to allow inundation of the estuarine emergent marsh and sustain back-channel habitat. Forested floodplain habitat would be created along the lowered levee adjacent to the mainstem river channel. A setback levee will be built to provide the same level of flood risk management as the existing left bank levee. The existing levee system around Fir Island is operated by Skagit Diking District 22. Skagit Diking District 22 is a connected levee system which, combined with a system of sea dikes, provides flood risk management to all of Fir Island (Figure 3- 2-4). Fir Island is a flat low-lying part of the Skagit Delta that relies on agriculture and tourism, including fishing, wildlife viewing, as well as popular and economically significant tulip and daffodil festivals. The Diking District 22 levee system has a 2% Annual Exceedance Probability (AEP) (50-year) residual risk based on levee screening conducted by the Corps. This levee system is part of the Corps PL84-99 Program and received a Levee Safety Action Classification (LSAC) of 4 – low risk in the 2014 Levee Screening Program fact sheet. Since the setback levee is to be built with the same residual risk as the current levee system, flood consequences for the remainder of Fir Island under the with-project condition would be the same as for the existing system.

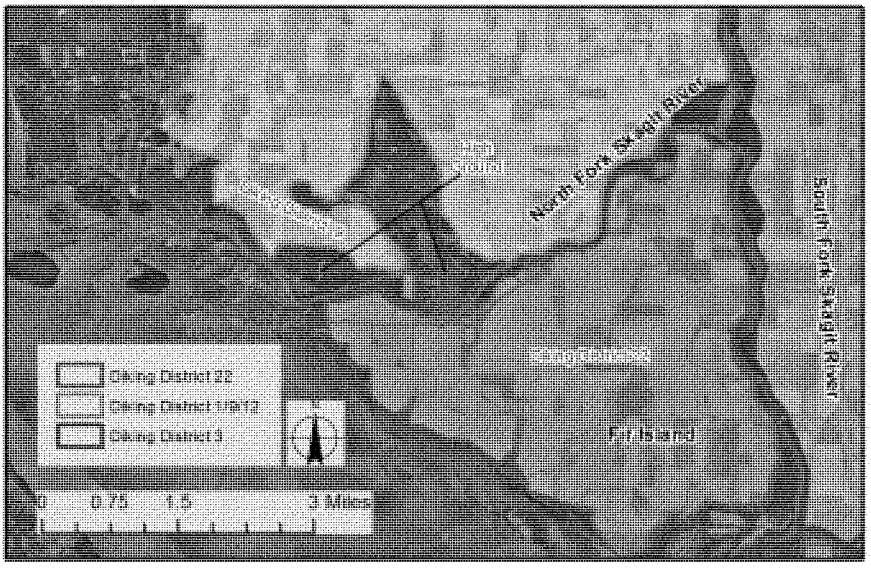

Figure 3- 2-4. North Fork Skagit River Delta levee system.

On the right bank of the North Fork Skagit River, the Diking District 9 levee with 0.2% AEP level of flood risk management lies just north of the project boundary and will not be affected by the project.

3-2.1.2 Project-induced changes obligating mitigation

No compensatory mitigation is included for this site as none is required. Implementation of restoration at this site would involve only minor construction activities in the aquatic environment. The restoration actions 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 based on the specific effects of the project.

3-2.1.3 Discharge-frequency relationships

The site is located on both left and right banks of the North Fork Skagit River. The predictions for river discharge for this area are taken from the Skagit River Flood Risk Management Feasibility Study, Hydrology Technical Document (USACE 2013). The estimates for the Skagit River near Sedro-Woolley and at the Best Road Bridge are shown in Table 3-2-1. Low probability flood discharges at the site are significantly lower at the site due to significant overbank flow and the flow split at the junction of the North Fork and South Fork Skagit Rivers.

Table 3-2-1. Peak discharge – frequency predictions for mainstem Skagit River at Sedro-Woolley and Best Road Bridge using HECRAS routed regulated synthetic hydrographs.

Location	10% AEP (cfs)	2% AEP (cfs)	1% AEP (cfs)	0.2% AEP (cfs)
Sedro Woolley	133,000	197,400	235,700	325,400
Best Road Bridge	61,600	83,300	85,400	86,300

3-2.1.4 0.2% Annual Exceedance Probability (500-year) flood

The area of potential hydraulic effect for the North Fork site is dominated by fluvial flows with some influence from coastal flooding. The only critical infrastructure at this site is the Best Road Bridge. The 0.2% AEP flood elevations are essentially the same as the 1% AEP flood elevations, thus the 0.2% AEP flood will not be evaluated separately.

3-2.1.5 Stage-discharge relationships

Current stage-discharge relationships were computed for the North Fork Skagit River in the Skagit River Flood Risk Management Feasibility Study, Hydrology Technical Document (USACE 2013). Table 3-2-2 shows the computed elevations at the Best Road Bridge. The 2%, 1% and 0.2% AEP elevations are essentially the same. In order to forecast new stage-discharge relationships and effects on adjacent levees in the Skagit Delta, a revised hydraulic model will have to be implemented that reflects the proposed geometry of the site. This will be addressed during PED.

Table 3-2-2. Stage-discharge relations as shown in recent USACE Skagit River Flood Risk Management Feasibility Study for the North Fork Skagit River Delta site (USACE 2013).

Location	10% AEP Stage (feet NAVD88)	2% AEP Stage (feet NAVD88)	1% AEP Stage (feet NAVD88)	0.2% AEP Stage (feet NAVD88)
Best Road Bridge	17.5	21.0	21.0	21.0

3-2.1.6 Flow duration

At present, it is not anticipated that a flow duration analysis will be required at the site.

3-2.1.7 Flood inundation boundaries and flood stage hydrographs

Figure 3-2-5 shows the effective 1% AEP (100-year) flood inundation levels from the Skagit County FEMA Flood Insurance Study (FEMA 1985). In order to forecast any changes in flooding pattern, a revised hydraulic model will have to be implemented that reflects the proposed geometry. This will be addressed during PED.

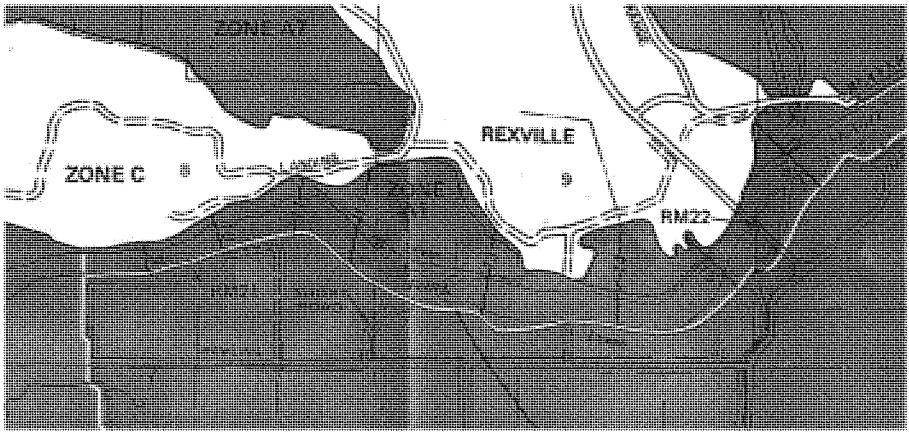

Figure 3-2-5. Effective FEMA 1% AEP (100-year) flood zone as adapted from Flood Insurance Rate Map (FIRM 530151 0425C) (FEMA 1985) (Elevations in NGVD29; NGVD29 + 3.79 feet = NAVD 88).

3-2.1.8 Reservoir yields

No reservoirs are planned as part of this site.

3-2.1.9 Risk and uncertainty analysis for sizing of the project under study

The existing levees would be lowered to elevations similar to those of the natural levees (about 13.5 feet above MLLW, 12 feet NAVD88), which are formed during flood events and exist further downstream. The setback levees will be built to provide the same level of flood risk management at Fir Island (AEP of 2%) as the existing levees.

Channel sizing:

Channels will be excavated to equilibrium dimensions as described in the *Applied Geomorphology Guidelines* (Attachment B). Channel top widths will vary between 30 and 100 feet, with depths between 4 and 12 feet below existing grade. A channel depth of 12 feet will allow for some infilling of the channels without impacting the performance of the restoration. How the new tidal channels will evolve is unknown, but the concept of natural evolution minimizes any risk because there are no specific discharge requirements for the new channels.

Sea Level Change

The North Fork site is located in the Whidbey Sub-basin of Puget Sound. Sea level change calculations for the Whidbey Sub-basin are based on the Seattle tide gauge and are calculated using the guidance in ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, and ETL-1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation (USACE 2013, 2014). Table 3-2-3 shows the range of sea level change projections for the 50-year project life as well as the 100-year horizon assuming a project start date in 2020. Changes are referenced to 1992, which is the midpoint of the most recent National Tidal Datum Epoch as established by NOAA. The high rate calculations indicate a sea level rise of 2.3 feet in 50 years after project start and a rise of 6.5 feet after 100 years.

The largest risk associated with sea level change at this site is the displacement of habitat upstream, with vegetated marshes becoming intertidal habitat and intertidal habitat becoming sub-tidal habitat. Tidal marshes can adapt to sea level change by building elevation to keep pace with the rising water levels, but this requires an adequate supply of sediment and/or organic matter accumulation. Future studies should include a sedimentation analysis to determine what impact the restoration will have on sedimentation

rates and if there is sufficient sediment accumulation to keep pace with the projected sea level change. The sedimentation analysis will be used to fine tune initial channel design and to assess the anticipated environmental benefits from the project over the design life.

Table 3-2-3. Projected sea level change (feet) Seattle (Gauge 9447130). Source: USACE Sea-Level Change Curve Calculator (2015.46).

Year	Low (feet)	Intermediate (feet)	High (feet)
1992	0	0	0
1995	0.02	0.02	0.02
2000	0.05	0.06	0.08
2010	0.12	0.15	0.24
2020	0.19	0.26	0.48
2030	0.26	0.39	0.79
2040	0.32	0.53	1.18
2050	0.39	0.69	1.64
2060	0.46	0.87	2.17
2070	0.53	1.07	2.78
2080	0.6	1.28	3.47
2090	0.66	1.52	4.22
2100	0.73	1.77	5.05
2110	0.8	2.04	5.96
2120	0.87	2.32	6.94

Figure 3-2-6 shows the top of levee profile for the Diking District 22 levee on the left bank of the North Fork Skagit River along with riverine water surface profiles for 50% through 1% flood events. These water surface profiles were developed using HEC-RAS for the Skagit River Flood Risk Management Feasibility Study (USACE 2013b) and represent the without-project condition. In the figure, Station 52500 is at the upstream end of the site and Station 65300 is at the downstream end. Although the top of levee is well above the 1% AEP water surface in this part of the levee system, other parts of the system are more vulnerable, leading to the overall 2% AEP residual risk for the entire Diking District 22. The current coastal BFE of 12.2 feet NAVD88 affects the lowest 2000 feet of the site but is contained by the levee. The incrementally higher lines represent respectively the 100-year low, intermediate and high assumptions for sea level change at the North Fork site. For the highest, 100-year high rate of sea level change, the coastal BFE would overtop the lowest 5000 feet of the levee. At this elevation the sea dikes that protect Fir Island, and that join the levee at its downstream end would also be subject to overtopping, so both sides of the levee would be affected by the BFE. The most downstream end of the levee would begin to be overtopped by the base coastal flood in 2070 (about 50 years post-construction) for the high rate of sea level change and in 2140 (about 120 years after construction) for the intermediate rate of change. This performance will be reassessed in PED once levee crest elevations have been refined.

The intent of the project is to restore ecosystem process by removing stressors. For levees, the project is designed to meet the current level of residual risk for Diking District 22 (2% AEP) only. Since the project is not authorized for flood control, future adaptation of levees for sea level change is not within the project authority. Since the current Diking District 22 levee system includes long segments of coastal dikes, it is assumed that adaptation of the Fir Island levee system to sea level change would be undertaken as a system-wide measure either by the diking district or under a separate authority. Elements of the levee

design that will be finalized in PED will include robustness considerations such as shallow side slopes and wide crest-widths. Some of these features may be useable by others to adapt to future sea level change.

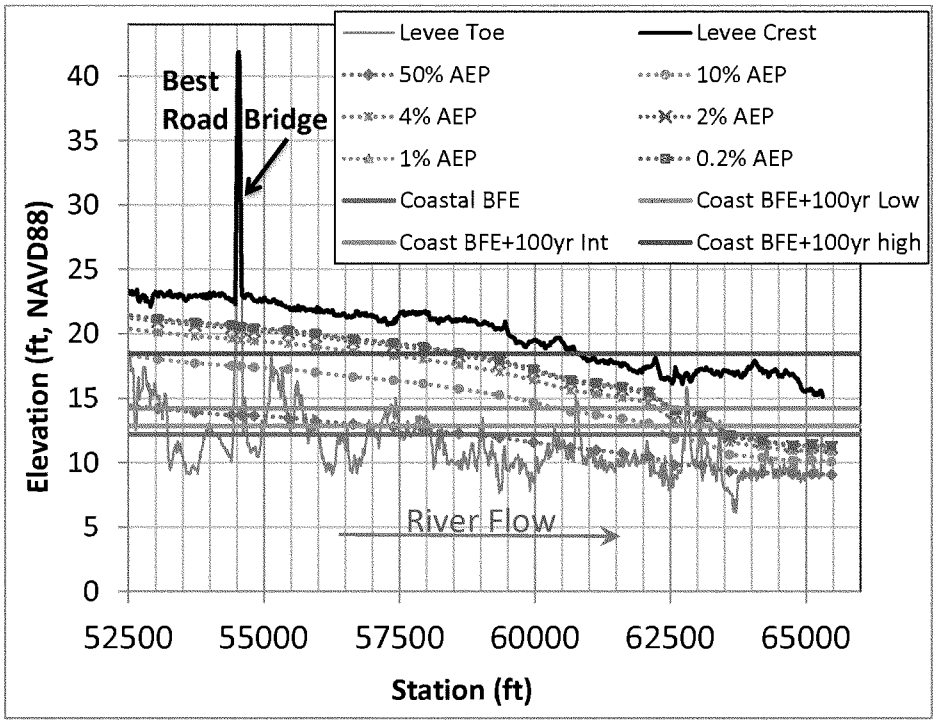

Figure 3-2-6. Effects of potential sea level change on the base flood elevation (without project) at the North Fork Skagit River Delta site.

Figure 3-2-7 shows the project features compared to current and possible future Mean Higher High Water (MHHW) elevations. The base level for the riparian berm breaches are below Mean Lower Low Water (MLLW), while the base levels for new tidal channels are at or slightly higher than the MLLW. The top of the riparian berms are above the current MHHW as well as above the 100 low and 100 year intermediate. For the 100-year high rate of sea level change, the riparian berms would be below MHHW at the end of 100 years.

The largest consequence associated with sea level change at this site is the displacement of habitat upstream, with freshwater habitat becoming intertidal habitat and intertidal habitat becoming sub-tidal habitat. Tidal marshes can adapt to sea level change by building elevation to keep pace with the rising water levels, with an adequate supply of sediment and/or organic matter accumulation. Further study in PED will include a sedimentation analysis to determine what impact the restoration will have on sedimentation rates, if sediment accumulation will keep pace with the projected sea level change, or if changes in habitat types are expected.

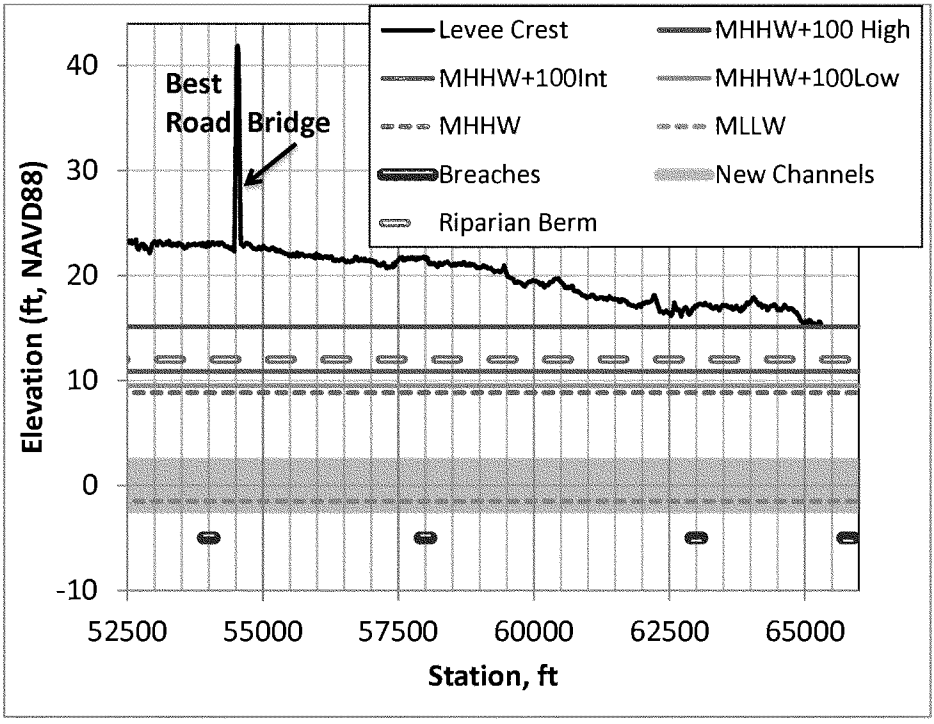

Figure 3-2-7. Effects of potential sea level change on diurnal tide fluctuations at the North Fork Skagit River Delta site.

Climate Change

ECB No. 2014-10 (USACE 2014) provides initial guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate change adaptation policy. There is a strong consensus among recent studies that future storm events in the Pacific Northwest region will be more intense and more frequent compared to the recent past (USACE 2015). The overall projected trends for the Pacific Northwest are summarized in the FR/EIS Section 3.6.5.1.

The Skagit River Basin Climate Science Report (Lee and Hamlet 2011), prepared for Envision Skagit and Skagit County, explores the potential impacts of climate change on Skagit River hydrology. The report describes potential changes in seasonal discharges (higher winter flows and lower summer flows) and increasing flood discharges. The Lee and Hamlet report forecasts flood peak increases could range from 4 to 64 percent by 2040, with an average of 23 percent, and 0 to 98 percent by 2080, with an average increase of 40 percent.

These projections would yield an average peak flow increase of 33% at the end of the project planning horizon in 2065. The risk of floods on the order of the current 1% AEP could increase to about 4% AEP. The frequency of flooding could increase significantly in the study area, however the amount of flow will vary by location. At the project site, since high flows cause so much overbank flow upstream, the relative increases in peak flow, water surface and flow speed are anticipated to be relatively minor. This is supported by the fact that the 0.2% AEP (500-year) water surface profile is on the order of 0.1 feet higher than the 1% AEP (100-year) water surface in the area of the project.

Higher winter flows, especially flood discharges, could result in an increase in sediment transport. In the Skagit River, discharges over 50,000 cfs at Mount Vernon now produce 21% of the annual sediment yield. Those flows are currently only exceeded 1% of the time on an annual basis. Should climate change result in higher discharges becoming more common, the sediment yield may increase accordingly. Higher sediment yields may cause increased deposition around the mouths of the North and South Fork Skagit Rivers. The potential impacts to river deposition are harder to estimate. That will depend on the future balance between sediment transport potential and the available sediment supply. The sedimentation analysis conducted during PED will provide an indication of whether more frequent high flow events will trend towards higher rates of sedimentation at the North Fork Site.

3-2.1.10 Water quality conditions

Water quality information has not been reviewed in detail for this site. The restoration is not anticipated to generate any long-term effects on surface water quality. Anticipated water quality effects are as follows:

- Construction-related turbidity and suspension of sediments may occur due to dike lowering and breaching. Sediment control will have to be carefully considered in the construction planning.
- Temporary increases in sedimentation may occur downstream of the site because of the release of sediment during the formation of any new distributary channels. These effects, together with other sedimentation issues, will be evaluated during PED.
- Levee lowering and channel construction may increase salinity within the site due to the increased tidal prism. Since the goal is to restore historic conditions, restoration of historic salinity patterns is presumed to be a desirable outcome. If needed, water quality sampling and analysis of water quality effects can take place during PED.

Rawlins Road, to the west of the site, was the subject of a study by Battelle (Yang and Khangaonkar, 2006) in connection with several restoration options around Fir Island. As part of the study, velocity, tidal elevation, salinity, and temperature time histories were collected at the northwest corner of the site using an S4 current meter mooring station. Instantaneous salinity and temperature profiles were also obtained near the station during instrument deployment and retrieval. The salinity measured during three weeks in June of 2005 averaged around 0.12 PSU (Practical Salinity Units) with occasional excursions to around 0.15 – 0.16 PSU.

3-2.1.11 Groundwater conditions

No groundwater information has been reviewed for this site. The lowering and breaching of dikes will allow an increased tidal prism within the site which may be accompanied by saltwater intrusion. Since the goal is to restore historical conditions, restoration of historical salinity patterns is presumed to be a desirable outcome.

3-2.1.12 Preliminary project regulation plan

The setback levees will be built to provide the same level of residual risk at Fir Island, an AEP of 2%, as the existing levees.

3-2.1.13 Preliminary real estate taking line elevations

The current real estate limits are delineated by the construction area, staging areas, and access roads and include the entire potential area of hydraulic effects. Real estate assumptions, valuations, and planning documents have been appropriately scaled for the current level of design. As additional surveys, modeling, and design are completed during the PED phase, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Integrated Final Feasibility Report and Environmental Impact Statement (FR/EIS), Appendix C, *Real Estate Plan*.

3-2.1.14 Criteria for facility/utility relocations

Buildings, roads, utilities, and other hard structures/surfaces within the setback area, including Blake's Resort, will be removed. For further details on the utility relocations see Section 3-6.3.

3-2.1.15 Criteria for identification of flowage easements required for project function

No flowage easements are anticipated for this site. This will be reviewed and confirmed during PED.

3-2.1.16 Criteria in support of project OMRR&R requirements

Operations, maintenance, repair, replacement and rehabilitation needs associated with the hydraulic function of the site are as follows:

- This restoration concept relies on the natural evolution of the floodplain and channels, therefore no hydraulic performance maintenance is anticipated. If site specific objectives aren't being met with the process based restoration features, there may be some adaptive management required. Adaptive management costs are separate from O&MRRR.
- The North Fork site will require periodic levee maintenance, such as vegetation control. If erosion develops that threatens the reliability of the new setback levee, costs have been included that allow for the replacement of 300 feet of the new setback levee.

3-2.1.17 Environmental engineering considerations

In the context of hydrology and hydraulics, environmental engineering is taken to mean water supply and sanitation. Existing water supply or sanitation systems will be decommissioned.

3-2.2 Residual Flooding Consequences – With Project Flooding

This section discusses the predicted hydraulic conditions after construction of the proposed restoration.

3-2.2.1 Warning time of impending inundation

There will be no residences or infrastructure within the site, except for the Best Road Bridge. Aside from regional warnings for possible flooding, no warning system is planned.

3-2.2.2 Rate of rise, duration, depth, and velocity of inundation

Unsteady flow analysis and flood flow routing is likely to be required for this site, however no analysis of rate of rise and flow duration is planned for flood flows. The depths and velocities at the levee removals and in the tidal channel due to the combined effects of river flow and tidal prism will be evaluated during PED.

3-2.2.3 Historic, 1% and 0.2% exceedance (100-year and 500-year) flood extents

Setting back the levees is likely to decrease peak water levels within the project area, for the estimated 1% AEP (100-year) event. Preliminary hydraulic modeling using HECRAS 1D indicates that levee setback will reduce the 1% AEP flood elevations from 1 to 2 feet. This will be reviewed during PED once accurate survey information is available and soils explorations have been performed to quantify the potential for levee settlement. The levee design will be revised as appropriate. For the purposes of quantity estimation for feasibility, because of the uncertainties in topography and soils characteristics, the assumed levee cross section has the same crest elevations as the current levee.

Since the setback levee is to be built with the same level of flood risk management as the current levee system, flood consequences for the remainder of Fir Island for the with-project condition would be the same as for the existing system.

3-2.2.4 Access and egress problems created by flooding

Best Road and Bridge cross the site. The bridge and approaches are above the 1% AEP (100-year) flood elevation. There would be no loss of access or egress during flood events due to the project. Area flooding may limit access to the bridge during floods of approximately 2% AEP or larger due to low points in the Dike District 22 levee system outside the project area.

3-2.2.5 Potential for loss of life as a result of 3-2.2.1 through 3-2.2.3

The potential for loss of life as a result of the restoration is low. Areas within the site will be inundated more often for low return interval floods. However, the entire site lies within the 100-year floodplain and is not likely to be occupied by people during floods.

3-2.2.6 Identification of any potential loss of public services

There are no identified public services within the site.

3-2.2.7 Potential physical damages

Potential physical damages that can occur during flooding will be addressed by the hydraulic analyses conducted during PED. This will include an evaluation of erosion and sedimentation in the channel adjacent to the site and impacts to the Best Road Bridge abutments.

3-2.3 Project Induced Flooding – Change from Pre-Project Conditions

This section describes the effects of the site on flood elevations, flood patterns, and flood frequency.

3-2.3.1 Information categories required by 3-2.2

Flooding at the North Fork site is dominated by fluvial discharge from the Skagit River with some influence from coastal flooding and tides. Lowering of the levees at the site is anticipated to decrease peak water levels during 100-year floods by up to 2 feet. Water levels within the site during smaller flood events will be affected by the increased tidal prism and the availability of new inflow pathways to the site. The increased flow in the site is a goal of the restoration effort.

Since the setback levee is to be built with the same level of flood risk management as the current levee system, flood consequences for the remainder of Fir Island for the with-project condition would be the same as for the existing system.

3-2.3.2 Anticipated frequency of induced flooding

The proposed work is expected to alter the pattern and frequency of flooding of the site. Areas within the site will be inundated more often for lower return interval floods, which is one of the goals of the restoration effort.

3-2.4 Inundation Risk 0.2% Exceedance (500-year Return Interval) Flood

Work at the site is not anticipated to change the frequency of 0.2% AEP flooding. The 0.2% AEP (500-year) flood elevations within the North Fork site are expected to be reduced due to the levee setback. This will be reviewed during PED once accurate survey information is available and soils explorations have been performed to quantify the potential for levee settlement. Since the setback levee is to be built with the same level of flood risk management as the current levee system, 0.2% AEP flood consequences for the remainder of Fir Island for the with-project condition would be the same as for the existing system.

3-2.5 Hydraulic Studies

This section discusses the hydraulic studies, construction considerations, and instrumentation and monitoring needs for the site. The anticipated hydraulic studies at this site are summarized in Section 3-21.

3-2.5.1 Hydraulic roughness determinations

If a hydraulic roughness determination is required to complete hydraulic analyses, then roughnesses will be determined using a combination of aerial photographs and field surveys during PED. Roughnesses will be calibrated using high water marks if available.

3-2.5.2 Water surface profiles

Current water surface profiles as reported in the Skagit River Flood Risk Management Feasibility Study, Hydrology Technical Document (USACE 2013) include the presence of the levee system surrounding Fir Island. In order to predict the with-project water surface profiles, a revised hydraulic model will have to be implemented that reflects the proposed setback levee using accurate survey information. This will be addressed during PED.

To estimate a rough value of water surface elevation change at the project site, the existing one dimensional HECRAS model was modified to remove the levees, lower the riparian berm height to 12 feet NAVD88 and include a ground elevation rise at the setback levee location. The new tidal channels were not modeled for this order-of-magnitude estimate. In most locations, the water surface elevation was 0.5 ft to 1.5 feet lower for the with-project condition as compared to the without-project condition.

The HECRAS model was also modified include two dimensional flow areas and was run in the current configuration as well as with the levees removed down to the riparian berm elevation of 12 feet. The 2-D model predicted a somewhat larger water surface elevation drop of 1.5 to 2.5 feet.

Since no current survey and channel elevations are available for this area, the above analyses were only done to confirm the expectations that water surfaces will be reduced by the setback of the levee, and not to refine the levee design. The cost estimate includes a setback levee design with top of levee elevations similar to those of the existing levee. Until accurate topography, bathymetry and soils characterizations are available, refinement of the levee design is not practical.

Stage-discharge relationships

Current stage-discharge relationships as reported in the Skagit River Flood Risk Management Feasibility Study, Hydrology Technical Document (USACE 2013) include the presence of the levee system surrounding Fir Island. In order to predict the with-project water surface profiles, a revised hydranlic model will have to be implemented that reflects the proposed setback levee using accurate survey information. This will be addressed during PED.

3-2.5.3 Head loss

Other than the head losses that will be incorporated into the revised hydraulic model, no additional head loss studies are planned.

3-2.5.4 Flow and velocity

Flow and velocity information from the revised hydraulic model will be used to assess the possibility for sedimentation, scour, and bank erosion in and around the site.

3-2.5.5 Structural sizing needed to meet design capacity including slope protection

The hydraulic analysis conducted during PED will refine the size and slope protection required for the setback levees. A 3' thick riprap and hydroseeded 2" topsoil layer are included in the current phase.

3-2.5.6 Water control facilities

The hydraulic analysis conducted during PED will include the size and slope protectiou required for the setback levee. A 3' thick riprap and hydroseeded 2" topsoil layer are included in the current phase. In addition, culverts required for interior drainage from Fir Island will be also be designed. Three 30" culverts with tidegates are included in the cost estimate for Feasibility phase.

3-2.5.7 Energy dissipating facilities

No energy dissipation facilities are proposed. (Not applicable.)

3-2.5.8 Erosion control requirements

Construction

Planning during PED will evaluate the best and most cost-effective methods for excavation. Earthwork will likely be accomplished using land-based equipment, but some limited earthwork with water-based equipment may be needed to excavate existing bank protection. This will be verified during PED. Barge navigation and positioning have the potential to suspend or erode bottom sediments in the river, so if this occurs, appropriate in-water sediment control measures will need to be used to minimize impacts. These may include excavating during extreme low tides, installing silt curtains, or possibly using a containment structure for work in the dry. Excavation of interior tidal channels should occur prior to breaching the outlets to minimize sediment impacts to the waterways. Temporary roadways adjacent to waterways need to be engineered to minimize sediment impacts.

With Project

No erosion control is currently anticipated outside of the construction boundaries since the goal of the project is to reestablish natural erosion and sedimentation processes. The hydraulic analysis conducted during PED will evaluate whether erosion control or slope protection is needed in areas within or adjacent to the site because of flow changes caused by the restoration.

3-2.5.9 Existing and post-project sedimentation

Although the entire Skagit River Estuary is an active accretionary environment, it is also very dynamic. The North and South Forks of the Skagit River have, in the past, carried different proportions of the sediment load and may continue to shift in their relative transport capacities. Distributary channels in the estuary may shift or avulse as part of natural sedimentation patterns. If conditions at the North Fork site remain as they are presently, the area will continue to subside from lack of new sediment inflows. The breaching and lowering of dikes and the consequent development of a distributary channel network will allow increased tidal prism and sediment inflows at the site. The work is also likely to result in increased flows to the downstream channels. The amount and potential areas of flow changes and sedimentation will be addressed during PED.

3-2.5.10 Water control and order of work during construction

Construction should be sequenced, with work on the setback levee and the interior areas first and levee lowering last. For further considerations refer to Section 3-2.5.8.

3-2.5.11 Criteria for facility/utility relocations

Buildings, roads, utilities, and other hard structures/surfaces within the setback area, including Blake's Resort, will be removed. For further details on the utility relocations see Section 3-6.3.

3-2.5.12 Other facilities to meet project goals

No other facilities are required in order to meet project goals. (Not applicable.)

3-2.5.13 Instrumentation and monitoring

A combination of field surveys and aerial photographs will be used to document biological and physical changes to the landscape. Monitoring data can be used to refine adaptive management and corrective measures, as needed. Some of the key monitoring needs and opportunities are summarized in the FR/EIS in Section 6.6.

3-2.6 Coastal Studies

Coastal base flood elevations were calculated by FEMA as a part of the Skagit County Flood Insurance Study. The base flood elevations are calculated by combining the effects astronomical tide (caused by gravitational effects of sun and moon), storm surge (rise in water levels as a result of wind stress and low atmospheric pressure), waves breaking onto the shoreline, producing an additional water level rise at the

beach (wave setup) and waves running up the beach (wave runup). The 1% annual exceedance coastal base flood elevation is at Elevation 12.19 (NAVD88).

The North Fork site is located along the North Fork of the Skagit River, approximately 3 miles upstream of the delta shoreline, and is only subjected to wind waves caused by local winds. Measurements at the nearby Whidbey Naval Air Station (Figure 3-2-8) show that the maximum wind speeds come from the southeasterly direction and rarely exceed 40 miles per hour. This could result in wave heights of 4 feet with a period of 4 seconds at the river delta shoreline; however, these waves would likely be attenuated by the time they reached the site. It is unlikely that wind waves are a significant forcing mechanism at this site. This site is chiefly dominated by diurnal tidal flows with periodic flooding from the North Fork Skagit River. The influence of wind wave activity, storm surge and wave setup will be evaluated further during PED.

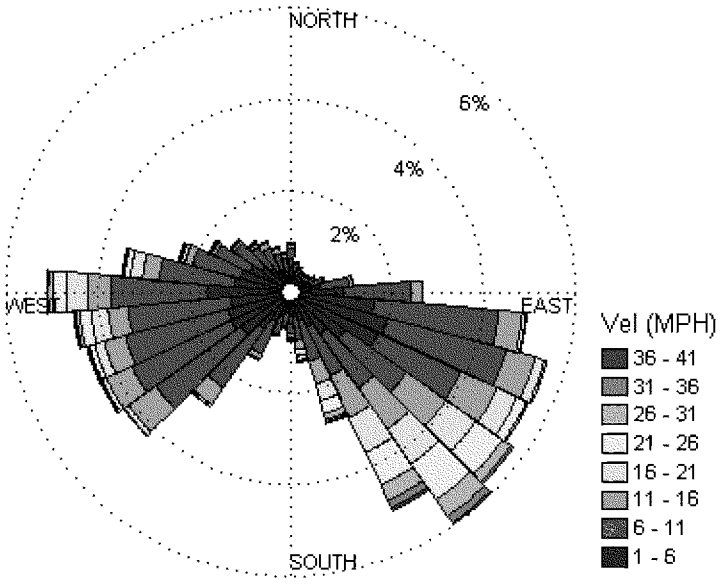

Figure 3-2-8. Wind Rose for Whidbey Naval Air Station

Plans formulated during the conceptual design phase for The North Fork site are based on a MHHW tidal datum of 8.84 feet (NAVD88). This datum is from the tide gauge at La Conner, Swinomish Slough (NOAA Gauge 9448558). Major tidal datums are summarized in Table 3-2-4. The final design tidal datums will be reviewed and established in PED.

Table 3-2-4. Major tidal datums for The North Fork site, La Conner, Swinomish Slough (Station 9448558)

Datum Description	Water Level (ft, NAVD88)
FEMA BFE (Coastal)	12.19
FEMA BFE (River)	12-21
Mean Higher-High Water (MHHW)	8.84
Mean High Water (MHW)	7.92
Mean Tide level (MTL)	4.55
Mean Sea Level (MSL)	4.45
National Geodetic Vertical Datum of 1929 (NGVD29)	3.79
Mean Diurnal Tide Level (DTL)	3.67
Mean Low Water (MLW)	1.19
North American Vertical Datum of 1988 (NAVD88)	0
Mean Lower Low Water (MLLW)	-1.51

A summary table for the anticipated coastal studies at this site is presented in Section 3-21.

3-2.6.1 Design of coastal shore protection projects (ER 1110-2-1407)

This site does not include coastal shore protection. (Not applicable.)

3-2.6.2 Effects on adjacent shores

Downstream of the site, the shoreline transitions from tidal freshwater wetlands to estuarine wetlands and finally to a river delta shoreline. The restoration is not likely to significantly alter the salinity and sedimentation patterns around the river delta. The effects on adjacent shores will be evaluated during PED.

3-2.7 Navigation Projects

The project at the North Fork site is unlikely to affect navigation channels. The southern entrance to the federally maintained Swinomish Navigation Channel is located approximately 3 miles downstream of the site. The Swinomish Channel is used by fishing and recreational boats and the channel is separated from flows from the Skagit River by a jetty that runs most of the way between Goat Island and McGlinn Island. (see Figure 3-2-9. Navigation chart for the vicinity of the North Fork Skagit River (Source: NOAA RNC Online).The project is not anticipated to have a significant impact on the navigation channel. The mouth of the North Fork Skagit River is over 7 miles east of commercial navigation channels in Puget Sound and separated from the Sound by Whidbey Island. Any potential impacts to navigation will be re-evaluated during PED.

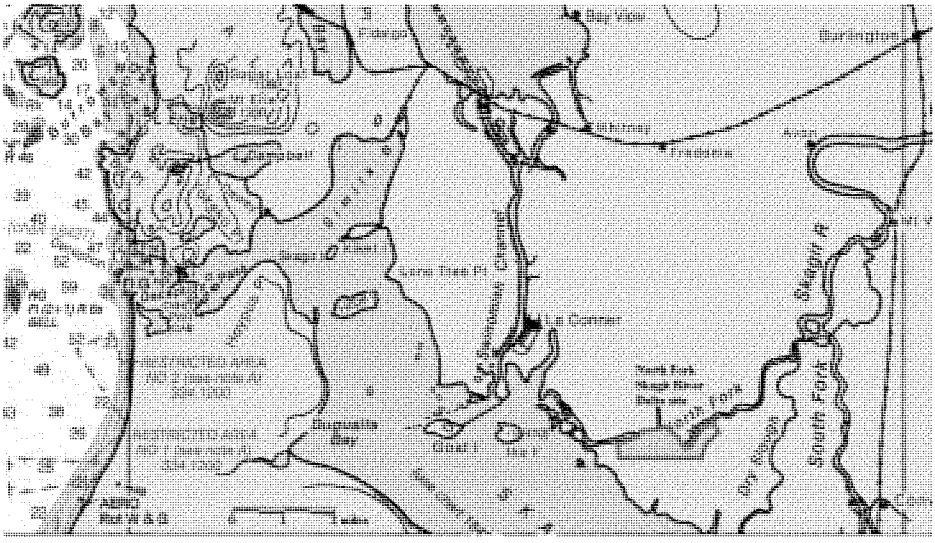

Figure 3-2-9. Navigation chart for the vicinity of the North Fork Skagit River (Source: NOAA RNC Online).

3-3 SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS

This section describes surveying, mapping, and other geospatial data information to support preparation of the FR/EIS and the *Real Estate Plan* (Appendix C of FR/EIS). A brief outline of additional surveying and mapping required for subsequent design, plans and specifications, construction, and operations is also included.

3-3.1 Surveying, Mapping, and Other Geospatial Data Information Used

Geospatial data for the North Fork Skagit River Delta site were obtained primarily from remote sensing applications. No site-specific topographic, bathymetric, property, or utility surveys were conducted during the conceptual design phase. LiDAR, aerial imagery, and other geospatial data were used to delineate topographic features, determine surface elevations, and to estimate areas, volumes, lengths, and other dimensions of key features using CAD and/or ArcGIS. High-resolution LiDAR was obtained from the Puget Sound LiDAR Consortium (2005 LiDAR; 3m grid; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://pugetsoundlidar.ess.washington.edu/lidardata/index.html). The Puget Sound Digital Elevation Model was used for combined bathymetry and topography of the Puget Sound lowland (Finlayson D.P., 2005; University of Washington; State Plane projection in NAD83 [horizontal datum] and NAVD88 [vertical datum]; available at http://www.ocean.washington.edu/data/pugetsound). Recent aerial photography (Aerials Express, 5/15/2009, 0.3m resolution, 2.45 m accuracy) was evaluated to determine recent site conditions. The conversion from Mean Lower Low Water (MLLW) to North American Vertical Datum (NAVD88) and to the NGVD29 datum was derived from the La Conner tide gauge (# 9448558).

Information on land ownership was derived from the Washington Public Lands Database. Additional parcel data, including parcel boundaries, were obtained from the Skagit County assessors' office (2010). Information on utilities, existing roadway geometry, and other site features was generally scaled off of aerial photographs because as-built drawings were not available. A site reconnaissance was performed in September 2010.

Designers consulted the Nearshore Geodatabase for additional site context. The Nearshore Geodatabase is available from the Washington State Geospatial Data Archive at: http://wagda.lib.washington.edu/data/geography/wa_state/#PSNERP. Metadata are provided in the *Geospatial Methodology Used in the PSNERP Comprehensive Change Analysis of Puget Sound* (Anchor QEA et al. 2009) (see Annex B). The geodatabase includes numerous datasets listed below:

- Shoreline
- Bathymetry
- Digital Elevation Model (DEM)
- LiDAR (terrestrial)
- Oblique aerial imagery (from the Washington Coastal Atlas)
- Hydrographic sheets
- Geology
- Slope stability
- Drift cells (net shore-drift)
- Streams
- Impervious surfaces
- Overwater structures
- Marinas
- Armoring
- Breakwaters/jetties
- Groins
- Levees
- Dams
- Nearshore fill
- Roads
- Railroads
- Land cover

Designers consulted the University of Washington Puget Sound River History Project 19th Century Coast Survey Topographic Sheets (2009) for information on historical geomorphic conditions. Conceptual designs were intended to replicate historical conditions and remove stressors to nearshore processes to the extent practicable and feasible. As a result, these datasets informed the selection of restoration strategies and features. Designers created additional GIS data layers (point files, line files, and polygon files) to represent civil design features, such as areas of lowland excavation, to be depicted on the plan

view drawings. "Designers also created simple line drawings in CAD to represent typical sections and estimate quantity take-offs. Limited surface modeling was used to aid new levee and existing levee excavation quantity take-offs."

3-3.1.1 Additional survey and mapping required

Substantial additional information will be required during the PED stage to refine the design assumptions, confirm real estate requirements, and develop plans and specifications. Additional survey, mapping, and other geospatial data needs include the following:

- Property/Utility Survey – More detailed information on property boundaries and utilities will be needed to finalize the design and support real estate negotiations. The survey would also be useful in providing more accurate preliminary designs and quantities for excavations, utilities, and removal of existing features.

- Topographic/Bathymetric Survey – The conceptual design was based on LiDAR and aerial photos, which have inherent inaccuracies. Site-specific topographic and bathymetric survey data will be needed to refine design of key elements, confirm that target elevations are appropriate for the desired ecosystem components (low marsh, etc.), and develop detailed construction and demolition plans. Survey data could also be used as a baseline for pre- and post-construction modeling, including hydrodynamic modeling. A temporary tide gauge may be required in the early design stages to obtain site-specific tidal statistics.

3-3.1.2 Timeline for incorporation of new mapping or other geospatial data

Planning, design, and implementation are expected to take several years. The site-specific surveys identified above are standard components of the design process and should be completed in the early stages of PED to ensure that the design work proceeds efficiently. Incorporating these data into the design process is not expected to delay the restoration.

3-4 GEOTECHNICAL

This section describes the geologic setting of the site, previous and recommended stndies, and proposed geotechnical explorations relevant to design features.

3-4.1 Geotechnical Information

3-4.1.1 Regional and Site Geology

Regional geologic mapping from the Washington State Department of Natural Resources (DNR) indicates the site is composed of nearshore deposits (Qn) and Skagit River alluvium (Qas) from the Holocene age (2004 Geologic Map of the Utsalady and Conway 7.5-minnte Quadrangles, Skagit, Snohomish, and Island Counties, Washington). The nearshore deposits are commonly soft, gray to olive gray sand and silty sand with occasional lenses of organic material. The Skagit River alluvium consists of flood overbank deposits of grayish brown to gray sand, fine sandy silt, silt, and silty clay with minor peat. A section of the geologic map is shown in Figure 3-4-1.

The North Fork of the Skagit River was glaciated during the Vashon ice event about 15,000 years ago. Once the glacier retreated, the river built a broad alluvial plain. Icewater melt and flooding helped to deposit sediments in the forming delta and estuary. After the retreat of the glacier, the surface geology has been under the influence of both tidal action and flooding by the river.

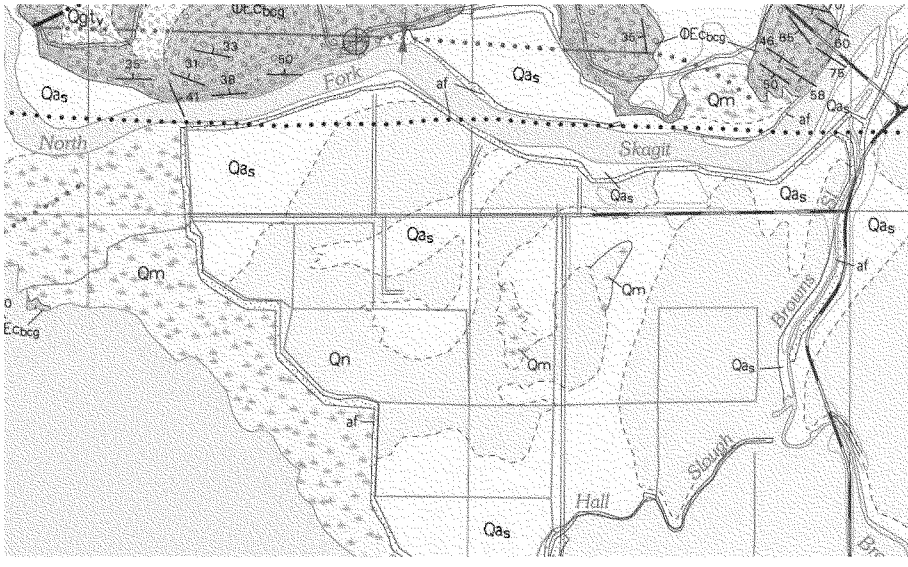

Figure 3-4-1. Geologic map of North Fork Skagit Delta.

Near-surface soils mapped in the *Soil Survey of Skagit County, Washington,* consist of Skagit silt loam, Snmas silt loam, Mt. Vernon very fine sandy loam, and Briscot fine sandy loam (NRCS 2012). Skagit silt loam is observed in floodplains and deltas and is described as silt and fine sand deriving from alluvium and volcanic ash. Sumas silt loam is observed in floodplains and deltas and is described as silt deriving from alluvium. Mt. Vernon very fine sandy loam is observed in floodplains and is described as ashy fine sand deriving from alluvium and volcanic. Briscot fine sandy loam is observed in floodplains and is described as fine sand and silt deriving from alluvium.

According to the Washington State Department of Ecology (Ecology) website, a boring was conducted nearby (400 feet to the east) in August 1994 (Ecology 2012). The boring was drilled to a depth of 42 feet with groundwater observed at 8 feet. The log recorded brown clay and silt from surface to 8 feet, gray sand with brown silt from 8 to 27 feet, and dark gray clay and silt from 27 feet to bottom of hole.

3-4.1.2 Completed explorations

At this time no subsurface explorations have been completed for this site. All subsurface information is based on soil surveys, geologic mapping, and available logs from Ecology. See Section 3-4.3 for the proposed subsurface exploration plan.

3-4.1.3 Selection of preliminary design parameters

Based upon research of soils and geology, subsurface soils on the site likely consist mostly of silts, clayey silts, and sandy silt. There are no plans to construct new structures. Therefore, no preliminary design parameters have been developed for this report. Soil parameters will need to be developed for the proposed setback levee once a suitable borrow source has been confirmed.

3-4.1.4 Geophysical investigations

No geophysical investigations have been conducted or are recommended. (Not applicable.)

3-4.1.5 Groundwater studies

No groundwater studies have been conducted. Groundwater elevation depends on local infiltration on Fir Island, flows from the Skagit River and the water surface elevation of Puget Sound. Groundwater elevations will be determined as part of the soils investigations to be conducted in PED.

3-4.1.6 Recommended instrumentation

No instrumentation is recommended. (Not applicable.)

3-4.1.7 Earthquake studies

No earthquake studies have been conducted or are recommended. There are no proposed structures or features requiring seismic design. (Not applicable.)

Earthquake loadings are not normally considered in analyzing the stability of levees because of the low risk associated with an earthquake coinciding with periods of high water. Depending on the severity of the expected earthquake, the importance of the levee, and the duration of flood event, seismic analyses to determine stability and liquefaction susceptibility may be required. This is not anticipated for this site.

3-4.1.8 Preliminary engineering analysis

The proposed setback levee should be designed in accordance with USACE Engineering Manual 1110-2-1913 Design and Construction of Levees. For levees constructed on soft subsurface conditions, stability and long-term settlement analyses are typically performed.

3-4.1.9 Excavatability analysis

Excavation will include removal of levees and reestablishment of a marsh channel network. No explorations or construction records were located, and therefore the levee embankment material is unknown. Based on soils and geology maps, the embankments likely consist of a combination of compact silt, clay, and sand. No bedrock or large boulders are anticipated; therefore, no blasting should be required. Majority of excavation will include the existing levee embankment composed of locally generated materials and native/agricultural soils within the proposed channels. Excavation of the levees and channels will likely be accomplished by excavator and/or bulldozer.

3-4.1.10 Anticipated construction techniques and limitations

The presence of the existing levee allows for construction of the setback levee year-round. Construction equipment shall be able to access the site by road. Track-monnted bulldozers, excavators, and end dumps will likely be used to constrnct the setback levee. Excavators and bulldozers will be used to lower the existing levee. Excavation of the breaches and levee lowering should be scheduled to coincide with periods of low water.

See Section 3-6 for additional construction notes.

3-4.1.11 Potential borrow sources and disposal sites

Material excavated to lower the existing levee and to excavate channels is nnlikely to be suitable fill for construction of the proposed setback levee. Disposal soils from the existing levee will likely be used to create low levees to support riparian corridors or stability berms and transition slopes for the proposed levee. Offsite disposal and borrow sites are available within a reasonable distance from the site. Multiple borrow and disposal sites are located along the Interstate 5 corridor within 30 miles of the site. Project plans include a 30 mile haul distance for armor excavation, provision of fill material, a 20 mile haul distance for pavements and sidecast of levee and channel excavations. Borrow and disposal sites shall be confirmed during PED. The uncertainties associated with confirming suitable borrow and disposal sites have been captured in the cost risk register.

3-4.1.12 Potential sources of concrete and materials

The procurement of concrete or materials is not anticipated. (Not applicable.)

3-4.1.13 Suitability of concrete and materials

If concrete and additional materials are required, their suitability will be evaluated at later stages of design or during construction.

3-4.2 Additional Studies and Analysis

Additional studies and analysis to be completed during PED or subsequent phases of design include the following at a minimum:

- Geotechnical investigation including subsurface explorations, testing, and field reconnaissance
- Levee Design: stability, settlement, and seepage analysis

3-4.3 Additional Explorations and Testing

The proposed subsurface exploration plan consists of test pits or site probing along the existing levee embankments, proposed levee alignment, and along the channel excavation areas. Explorations for the proposed levee should be conducted in accordance with Engineering Manual 1110-2-1913. This will include a combination of test pits and borings along the levee alignment. Depth of borings and test pits for the levee should be a minimum of 10 feet and spaced approximately every 200 feet. Site probing in excavation areas will likely be less than 5 feet below the ground surface. Test pits will be accomplished with a backhoe or small excavator, and site probing uses manually operated small augers. The recommended boring method is mud rotary.

Sampling in the soil borings will be accomplished using standard penetration test (SPT) with samples taken typically every 2.5 feet for the top 25 feet and every 5 feet for the rest of the boring depth. Proposed soil lab testing will include moisture content, grain size analysis, and percent finer than #200 sieve. Atterberg limits and consolidation tests are recommended for cohesive soils, and unconfined compressive strength test for rock cores.

The subsurface exploration plan will be reevaluated and coordinated with hazardous and toxic material investigations during PED to include chemical sampling and testing (See Section 3-9).

3-4.4 Laboratory-testing Program and Evaluations

No laboratory testing or evaluation of materials has been completed at this time. Testing to be completed during PED is outlined in Section 3-4.2.

3-5 ENVIRONMENTAL ENGINEERING

This section describes environmental engineering factors relevant to the proposed design features.

3-5.1 Use of Environmentally Renewable Materials

At this design stage, use of environmentally renewable materials is not planned. However, if renewable materials are available they could be incorporated into the design. Specific details will be developed during subsequent design stages.

3-5.2 Design of Positive Environmental Attributes into the Project

The North Fork River Delta site was selected to address River Delta restoration objectives to protect and restore freshwater input and tidal processes where major river floodplains meet marine waters. The proposed action involves the lowering the existing levee and selectively breaching to allow inundation of the estuarine emergent marsh and sustain back channel habitat. Forested floodplain habitat will be created along the lowered dike adjacent to the mainstem river channel.

3-5.3 Inclusion of Environmentally Beneficial Operations and Management for the Project

Design and construction will incorporate sustainable and ISO 14000 compliant practices. The U.S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOPs) are designed to provide direction on achieving better stewardship of air, water, and land resources while showing the connection between managing those resources and protecting environmental health. The EOPs are to ensure that USACE actions consider the environment and are sustainable now and in the future.

3-5.4 Beneficial Uses of Spoil or Other Project Refuse during Construction and Operation

Beneficial uses of spoil or other refuse are possible. Phase 2 emphasizes the use of material generated by levee lowering and channel excavation to create low berms in the forested wetland elevation range to increase the survival of the riparian forest in the subsided areas. Excavated material from all interior channels would be sidecast adjacent to the channels to create low discontinuous berms at elevations suitable to support a riparian woodland corridor. If spoils or other refuse materials are available for reuse, they could be incorporated into the design. Specific details will be developed during subsequent design stages.

3-5.5 Energy Savings Features of the Design

At this design stage, energy savings features have not been incorporated. In accordance with the EOPs, energy savings features will be a component of the design to the maximum extent practicable. The FR/EIS describes measures to minimize energy consumption for the purpose of reducing greenhouse gas emissions. These measures would also serve to minimize energy consumption.

3-5.6 Maintenance of the Ecological Continuity in the Project with the Surrounding Area and Within the Region

The restoration will increase ecological continuity within the site and with the surrounding area. This is one of several sites designed to restore the productivity and increase interconnectivity of the Puget Sound ecosystem.

3-5.7 Consideration of Indirect Environmental Costs and Benefits

All direct, indirect, and cumulative environmental costs and benefits were evaluated during the environmental impact assessment and alternatives analysis recorded in the Final FR/EIS.

3-5.8 Integration of Environmental Sensitivity into All Aspects of the Project

Construction will be conducted to ensure no long-term deleterious impacts to the ecosystem will occur. Best management practices will be incorporated into the contract documents. Best management practices will cover erosion and sediment control, stormwater management, spill response and hazardous material management, trash and debris management, air emissions from construction vehicles, and noise standards.

3-5.9 Use of Environmental Review Guide for Operations (ERGO) with Respect to Potential Future Environmental Problems

This is not a USACE operating facility. (Not applicable.)

3-5.10 Incorporation of Environmental Compliance Measures into the Project Design

All applicable laws and regulations will be followed during design and construction in accordance with the USACE contract documentation.

3-6 CIVIL DESIGN

This section discusses the key elements of the civil design including the selection of the site and evaluation of alternative layouts, alignments, and components.

3-6.1 Site Selection and Project Development

Extensive diking of the North Fork Skagit River has caused substantial loss of estuarine connectivity. The proposed restoration would set back flood risk management levees on both sides of the North Fork, from the former inlet of Dry Slough to the western terminus of the levee system near Rawlins Road. The action seeks to restore natural levees and create additional emergent marsh and riverine wetlands.

A brief description of the project is included in the Skagit Chinook Recovery Plan (SRSC and WDFW 2005). The plan lists this action as a project with a "long-term restoration horizon," meaning that it is generally less well developed and has uncertainties that must be addressed before implementation. The same plan includes a number of other setback projects proposed along the North Fork at Thein Farm, Rawlins Road Levee, and Blake's Bottleneck. A feasibility study of the Rawlins Road project has been conducted (Yang and Khangaonkar 2006). Given their geographical proximity, there is potential synergy between the North Fork levee setback and these other projects. The full restoration alternative presented here is a combination of the North Fork at Thein Farm, Rawlins Road Levee, and Blake's Bottleneck projects.

A restoration alternative that proposed less extensive work was considered but was not selected during cost effective analysis. The alternative selection process is documented in Chapters 4 and 5 of the FR/EIS.

Table 3-6-1 summarizes the key design elements associated with the proposed restoration. Annex 3-1 contains exhibits that depict the proposed restoration design elements.

Table 3-6-1. North Fork Skagit River Delta Key Design Elements.

Item	Description of Item	Quantity
Lower Levees and Build Riparian Berm	Excavate lowlands to lower 15,691 lf of existing levee to elevations similar to natural levees (13.5 ft MLLW, 12 ft NAVD 88 on the inboard side of the site, sloping down to 10.5 ft MLLW, 9.0 ft NAVD 88 on the main channel bank); Excavated material to be placed landward of existing levee to create 15,130 lf of floodplain berm approximately 100 to 150 ft wide (width to be determined by amount of material available) with the exception of 10,260 cy that will be used to block existing distributary channel west of Brown's Slough Road (described below)	211,820 cy
Excavate Breaches in Lowered Levee	Excavate lowlands to breach lowered levee in 4 locations. Breaches will be constructed to dimensions of 5th order channel; assume 50-foot wide benches at 7 ft NAVD88 (8.5 ft MLLW) installed on either side of the breach. At the end of the 50 ft bench, 10H:1V slopes extend up to between 9 .0 and 11.0 ft. This section results in an excavation of 45 cy/LF (at 9.0 ft NAVD88 top elevation) to 79 cy/lf (at 11.0 ft NAVD88 top elevation)	29,720 cy
Excavate Tidal Channel Network	Excavate 19,617 lf of tidal channels and sidecast generated material adjacent to the channels to create low berms that will support a riparian corridor. Excavation includes: 2,349 lf of second-order channel; assume 3 ft bottom width at elevation 2.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 6,953 lf of third-order channel; assume 3 ft bottom width at elevation 0.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 7,702 lf of fourth-order channel; assume 3 ft bottom width at elevation -2.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 2,613 lf of fifth-order channel; assume 3 ft bottom width at elevation -5.0 ft, 5H:1V sideslopes, and average surface elevation of 6.5 ft	179,315 cy
Block Distributary Channel	Place excavated material from levee lowering to block distributary channel located 2,650 ft downstream of Best Road bridge; assume 158,240 sf area with an average depth of 1.75 ft	10,260 cy
Remove Shore Armor	Remove 16,140 lf of riprap armoring from existing levee (13,000 lf along south bank, 3,140 lf along north bank); assume entire length of levee is riprap composed of average of 5 ft height and 3 ft wide, with a density of 1.5 ton/cy	13,400 tons
Remove Buildings	Remove 17 buildings distributed throughout the project area including Blake's Resort and along Rawlins Road within the proposed levee lowering footprint; approximate area calculated from GIS	45,024 sf

Item	Description of Item	Quantity
Remove Pavement and Boat Ramp at Blake's Resort	Remove pavement at Blake's Resort; approximate area calculated from GIS	139,906 sf
	Remove boat ramp; assume 100 ft x 300 ft	30,000 sf
Remove Roads	Remove pavement from roads in newly setback area between lowered levee and new flood risk management levee; approximate area calculated from GIS	104,353 sf
Build New Levee	Construct new flood risk management levee beside Rawlins Road, Brown's Slough Road-Fir Island Rd, and Moore Road. Assume 12,317 lf. 25.6 cy/lf assumes levee crest from 15 to 22 feet NAVD 88, 15 ft crest width, 3H:1V sideslopes,1 foot overbuild for settlement and 1 foot of unsuitable soils. Levee construction includes the installation of three 100ft long interior drainage culverts with tide gates and 12,317 lf of riprap (69,920) covered with 2 feet of topsoil and hydroseeded on the riverward side (43,300 cy)	314,800 cy
Plant Vegetation	Plant riparian vegetation along slopes of lowered natural levee and sidecast berms and along realigned levee at Rawlins Road, Brown's Slough Road, and Moore Road. Assumes 85,238 sq. yds channel plantings, 66,416 sq. yds levee hydroseed, and 90,222 sq. yds sidecast plantings.	50 acres (approx.)

3-6.1.1 Basis of Design

The proposed action will restore the riverine floodplain and tidal connectivity along the lower reach of the North Fork of the Skagit River. This will require constructing a new flood risk management levee further inland. The existing levee would be lowered and selectively breached to allow inundation of the estuarine emergent marsh and sustain back channel habitat. Forested floodplain habitat would be created along the lowered levee adjacent to the mainstem river channel.

The primary stressors are armored levees preventing deltaic estuarine processes from occurring. Hydraulic processes related to frequency and depth of inundation are eliminated. Similarly, geomorphic processes such as sedimentation, channel avulsion and channel migration are prevented. This, combined with agricultural practices, has resulted in significant subsidence (2 to 4 feet) of the former emergent marsh/scrub- shrub habitat. Breaching and lowering of the levees to suitable elevations is intended to restore combined tidal/freshwater (low salinity) hydrology to support channel formation, emergent marsh, forested floodplains and scrub-shrub wetland community development. Specific process-based restoration objectives to be achieved with this action include: (1) tidal channel formation and maintenance; (2) tidal flow; (3) distributary channel migration; (4) erosion and accretion of sediments; and (5) exchange of aquatic organisms.

The action would create a continuous floodplain corridor along the length of the south bank of the North Fork, and an area of floodplain along the north bank of the North Fork (Exhibit A) by setting back the flood risk management levee. The project area includes the existing site footprint, the adjacent Rawlins Road setback project area, and Blake's Resort – a total project area of 310 acres. These expanded floodplains would increase flood capacity along the North Fork, and potentially lower flood levels in the project vicinity and to some extent upstream of the project site.

Inundation of Fir Island would continue to be prevented by replacement of flood risk management levees constructed along the southern edge of the site on the north side of Rawlins Road. The crest elevation of the new levees will be 21.5 feet MLLW (20 feet NAVD88 based on the La Conner tide gage), the same crest elevation as the levee it replaces. On the north side of the river, no new flood risk management levees are required as the setback area grades into rising land.

The existing levees would be lowered to elevations similar to that of the natural levees (about 13.5 feet MLLW, 12 feet NAVD88), which are formed during flood events and exist further downstream. This would restore the natural overtopping processes that occur during floods. Buildings, roads, utilities, and other hard structures/surfaces within the setback area, including Blake's Resort, will be removed. The material excavated during the lowering of the crest of the levee would be placed on the landward side of the existing levee to create a forested floodplain berm 100 to 150 feet wide. The width of the berm will be determined by the amount of material available. The berm will be constructed up to a maximum elevation of about 13.5 feet above MLLW (12 feet NAVD88).

Breaches through the lowered levees would allow unimpeded tidal inundation of the estuarine emergent marsh in the setback area. These breaches would be about 120 feet wide, with an additional 100 feet of the adjacent levee on either side lowered to 8.5 feet MLLW (7 feet NAVD88) to provide additional capacity at higher water levels. Channels running parallel to the mainstem river channel would drain the setback area through the breaches and create back channel habitat. Such habitat may take several decades to evolve unassisted. To accelerate their evolution, these breaches and channels will be excavated to equilibrinm dimensions as described in the *Applied Geomorphology Guidelines* (Attachment B). Excavating the channels will also reduce the possibility of channel migration and the erosion of the flood risk management levee. Channel top widths would vary between 30 and 100 feet, with depths between 4 and 12 feet below existing grade. Approximately 20,000 lf of channel would be excavated. Material generated by channel excavation will be sidecast to increase heterogeneity of the setback area, help establish forested floodplain, and reduce handling and hauling costs.

During PED phase the PDT will examine trade-offs and engineer the recommended alternative to minimize costs while optimizing desired benefits. This will be accomplished once the site investigations and surveys recommended for PED have been completed.

Since 1860, land development on the delta has removed a large proportion of the estuary from the landscape, fundamentally altering the geomorphic processes that form and sustain delta ecosystems. The diking of distributary channels has had a significant impact on estuarine wetlands and tidal channels in the delta (Collins 1998). The 1886 topographic sheet (T-sheet) already showed extensive diking on the North Fork and on Fir Island. Post-restoration site conditions are intended to resemble or replicate the historical morphology to the extent feasible.

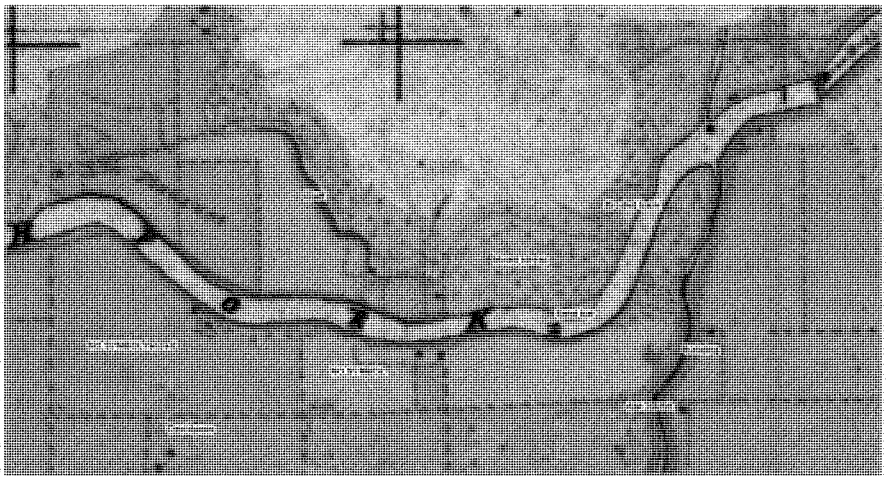

Figure 3-6-1. Historic map (T-Sheet) and river history project data.

3-6.1.2 Constructability

The present leveed nature of the site would allow for construction of the tidal channel network and the new levee year-round. The new levee would be constructed first with imported material. The new flood risk management levee and upper portions of the tidal channel network could be constructed primarily with upland equipment, including scrapers and end dumps. Excavators may be needed to create portions of the tidal channel network due to high groundwater levels.

Following construction of the new flood risk management levee, the existing levee adjacent to the North Fork may be lowered and widened primarily with upland equipment, provided this work occurs during the dry season. Breaches would require work with excavators.

Final levee lowering and breaching should be coordinated, including a plan for access as tidal waters enter the site.

It is assumed that construction access will likely be brought onsite by land, but further evaluation will be needed in succeeding stages of design. See Section 3-10 for additional information on construction procedures and Section 3-20 for the anticipated schedule for construction.

3-6.2 Real Estate

Real estate assumptions, valuations, and planning documents have been appropriately scaled for the current level of design. As additional surveys, modeling, and design are completed during PED, the real estate documentation will be modified accordingly. For the current real estate status, refer to the Final FR/EIS, Appendix C, *Real Estate Plan*.

3-6.3 Removals and Relocations

This action would require acquisition of several privately owned properties. Numerous buildings located along Rawlins Road would need to be removed. Blake's Resort, a small private RV park and boat launch would need to be removed. A cultural resource survey will be done in PED to determine if any of the standing structures to be removed are over 50 years of age and are eligible to the National Register or if there are national register eligible archaeological sites within the restoration area. Potentially, sanitary

sewer or septic related to the existing buildings may require removal. Associated with the restoration is the removal of buried utilities and overhead power within the site boundaries. The cost estimate has been developed assuming that only utility removals will be required. In the unlikely case that it is necessary to reconnect or relocate utilities to properties outside the project boundary, this cost has been included in the cost risk register. Cultural resources costs related to the mitigation of National Register eligible historic properties are included in the overall project cost estimate.

Table 3-6-2. Facility / Utility Removals

Facility / Utility	Activity	Subsequent Design
Overhead power distribution and transmission lines	Determine locations and assess removal or relocation if applicable	Coordinate with utility owner on phasing of work.
Fiber Optic	Determine locations and assess removal or relocation if applicable	Coordinate with utility owner on phasing of work.
Gas lines	Determine locations and assess removal or relocation if applicable	Coordinate with utility owner on phasing of work.
Sanitary sewer septic systems	Determine locations and assess removal or relocation if applicable	Need for decommissioning analyzed during PED.
Water wells	Determine locations and assess protection or removal if applicable.	Need for decommissioning analyzed during PED.

3-7 STRUCTURAL REQUIREMENTS

This section discusses the structural elements of the proposed restoration including preliminary design requirements and criteria for bridges or roads, a description of major structures and construction considerations, and recommended analyses.

3-7.1 Functional Design Requirements and Technical Design Criteria

No new bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.2 Survey, Hydrologic, Hydraulic, and Geotechnical Data Used

No new bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.3 Site Selection Studies

The site selection is summarized in Section 3-6.

3-7.4 Major Structures

No new bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.5 Describe Evaluation and Selection of Substructure Alternatives Based On Economy and Performance

No bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.6 Construction Considerations

No new bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.7 Stability Analyses

No bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.8 Stress Analyses

No bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.9 Thermal Stress Analyses

No bridges or structures are planned as part of this restoration. (Not applicable.)

3-7.10 Other Analyses

Not applicable.

3-7.11 Additional Studies, Tests, Analyses

Additional investigation and studies may be needed for other site requirements unrelated to the infrastructure. See Section 3-21 for a complete list of recommended additional studies and investigations.

3-8 ELECTRICAL AND MECHANICAL REQUIREMENTS

Electrical and mechanical structure requirements are not applicable to this site.

3-9 HAZARDOUS AND TOXIC MATERIALS

A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments*, and ER 1165-2-132: *HTRW Guidance for Civil Works Projects*. The Phase 1 Environmental Site Assessment report is attached in Annex 3-1.

The assessment revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have tbe potential to affect work at the North Fork site.

3-10 CONSTRUCTION PROCEDURES AND WATER CONTROL PLAN

The proposed restoration will involve earthwork and exposure of bare ground during lowering and breaching of levees, and excavation of channels. At this stage of design, it is assumed that standard best management practices will be implemented to control erosion and sedimentation and ensure construction areas are stabilized as needed to prevent adverse impacts. A standard temporary erosion and sediment control plan will be developed during PED.

The proposed restoration will not require in-water work during channel creation. For channel creation, work can be sequenced to avoid in-water work. Channel excavation will take place prior to breaching of the levees to reduce the likelihood of releasing sediments into downstream waters. Standard soil cover and stabilization practices will be implemented to stabilize the channels prior to introduction of water.

Specific measures for construction procedures and water control will vary depending on the location and nature of the work associated with each site. State and Federal resource agencies will impose specific timing restrictions on in-water work to protect fish and wildlife, and the Corps will adhere to conservation measures detailed in environmental compliance documents. In addition, specific measures may be required to protect downstream infrastructure or built environments. The erosion and water quality control plan will also need to consider and incorporate the findings of future analyses for hazardous and toxic materials at the site (as described in Section 3-9). A complete description of best management practices will be determined during PED.

3-11 INITIAL RESERVOIR FILLING AND SURVEILLANCE PLAN

The proposal is for ecosystem restoration. (Not applicable.)

3-12 FLOOD EMERGENCY PLANS FOR AREAS DOWNSTREAM OF CORPS DAMS

The proposal is for ecosystem restoration. (Not applicable.)

3-13 ENVIRONMENTAL OBJECTIVE AND REQUIREMENTS

Feasibility-level information to develop designs, plans, and specifications, and to execute construction and operations is included in the Project's supporting documents including the U.S. Fish and Wildlife Service report titled "Strategic Restoration Conceptual Design - Preliminary Environmental Contaminant, Cultural Resource, and Endangered Species Site Evaluations." The enviroumental information developed for the analysis in the FR/EIS provides additional environmental objectives and requirements for final site design development. As summarized in Section 3-6, Civil Design, substantial environmental information was developed for the FR/EIS regarding environmental problems, opportunities, and constraints such that the Corps could estimate costs of the restoration sites and prepare the Real Estate Plan. The Corps will adhere to requirements stated in the Endangered Species Act consultation documents, Clean Water Act Section 401 certification, and other site-specific environmental compliance documents. The Corps has prepared a Programmatic Agreement (PA) for Section 106 of the National Historic Preservation Act compliance. As outlined in the PA, cultural resource investigations are necessary in the PED phase to deterunine if National Register eligible historic properties are located in the restoration project area prior to construction. The Monitoring and Adaptive Management Plan will be used to determine whether the site is meeting environmental objectives after construction.

3-14 RESERVOIR CLEARING

The proposal is for ecosystem restoration. (Not applicable.)

3-15 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION (OMRR&R)

OMRR&R costs for the North Fork Skagit River Delta restoration are related to the following:

- Levee maintenance and repair including allowance for repair of up to 300 feet of levee once during a 50 year period.
- Vegetation costs such as removing invasive plants as well as site watering for plant establishment over the first 2-3 years prior to the start of adaptive management.

- Yearly culvert inspection and maintenance such as removal of debris and sediment.

Annual OMRR&R is estimated at $36,000 for the 50-year project period. Additional assessment of O&MRR&R activities will be conducted during PED.

The proposed setback levees will be designed in accordance with applicable USACE engineering manuals. Operation and maintenance of these structures will be necessary to ensure proper functioning of the structures and will be the responsibility of the local sponsor as detailed in the applicable O&M manual. Maintenance zones should extend 15 feet from both the riverward and landward setback levee toe. This maintenance zone should remain free of unwanted vegetation and unauthorized encroachments. Sod cover and riprap maintenance will be necessary to ensure proper functioning of erosion protection.

At the completion of the restoration project, an operation manual detailing proper maintenance practices for the setback levees will be provided to the local sponsor. Since the levees would be congressionally authorized and federally constructed, they will be ICW (Inspection of Completed Works) projects and automatically enrolled (eligible) in the PL 84-99 rehabilitation program.

3-15.1 33 CFR Part 208 Projects

The site is not a flood control project to be maintained and operated according to regulations in 33 CFR 208. (Not applicable.)

3-15.2 Channel or Basin Clean Out Projects

The restoration does not include channel or basin cleanout activities. (Not applicable.)

3-15.3 Multiple-Purpose, Complex Projects with Power Production

No power production is proposed. (Not applicable.)

3-15.4 Frequency and Cost of Maintenance Dredging

No maintenance dredging is proposed. (Not applicable.)

3-16 ACCESS ROADS

Temporary construction access roads will be needed to maximize the efficiency of earthwork operations and haul unsuitable materials offsite. It is assumed that construction access will likely be brought onsite by land. Further evaluation will be conducted in succeeding stages of design.

3-17 CORROSION MITIGATION

No new corrodible construction is proposed. (Not applicable.)

3-18 PROJECT SECURITY

The proposal is for ecosystem restoration. (Not applicable.)

3-19 COST ESTIMATES

The North Fork construction cost estimate of $99,299,000 (March 2016 dollars) consists of costs for removal of levee, shoreline armor, excavation of channels and construction of a setback levee along the

North Fork of the Skagit River. Other work includes levee breaching, demolition of existing structures, and plantings.

The largest cost driver is relocations including the setback levee ($58,987,000 construction cost, March 2016 dollars). Other substantial cost drivers include channel construction, the riparian planting along all the lowered dikes, and the demolition of existing structures.

Following a formal cost and schedule risks analysis, a project contingency of 36% was developed. The largest cost risk was the potential for construction modifications due to unexpected site issues. Also, there is a likelihood that newly built levees will settle and will require additional material to maintain the required prism. Schedule risks are entirely controlled by the potential for work to need to stop during the rainy seasons. Additional mobilizations and lost time would be incurred because of this.

There are non-cost related risks as well. There could be either erosion or sedimentation in excavated channels during river flooding. Channels will need to be watched following construction as part of the overall monitoring plan.

Opportunities to reduce the project cost include a potential for reductions in material prices. During PED, the team may design less expansive plantings or a more strategic planting scheme to reduce costs without sacrificing restoration success.

3-20 SCHEDULE FOR DESIGN AND CONSTRUCTION

The proposed restoration at the North Fork Skagit River Delta is considered to be relatively straightforward. Based on the low level of complexity, the anticipated design period for the site is approximately two years. This includes preparation of final design, plans and specifications, and the construction contract.

The anticipated construction period for Construction of the setback levee, removal of the river side levees and bank armoring levees, channel excavation, grading and construction of breaches is 2 years. Any in-water construction activities will take place during established work windows. Setback levee construction would occur first to maintain the integrity of the Dike District 22 levee system. Armor removal and lowering of the existing levee adjacent to the river may be accomplished primarily with upland equipment, provided this work occurs during the dry season. The present leveed nature of the site would allow for construction of the channel network within the site year-round. Construction would have to be sequenced with setback levee and interior marsh work first, breaches and levee lowering last.

Property acquisition and environmental compliance timelines are not included in this duration. The time required to complete these upfront activities is unknown, but is assumed to be relative to the length of the anticipated design period for the site as described above.

3-21 STUDIES TO BE COMPLETED IN PED

Table 3-21-1 summarizes recommended studies and additional investigations to be conducted at the site to support subsequent stages of design and implementation. Unless otherwise noted, these studies are recommended to take place during PED. In the table, studies are classified according to the following purposes:

- Data required for design, cost estimation or project compliance,
- design analysis to minimize project construction costs,
- design analysis to optimize environmental benefits,
- identification of induced flooding,
- and identification of actions needed for O&M.

Table 3-21-1. Studies Recommended for the North Fork Skagit River Delta Site

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Property Investigation/Survey	• Compile more detailed information on parcel ownership and property boundaries to finalize the design, confirm acquisition requirements, and support negotiations with property owners.	X	X			
Topographic/ Planimetric/ Bathymetric Survey	• Acquire site-specific topographic and bathymetric survey data to refine design of key project elements, develop detailed construction and demolition plans, and serve as a baseline for pre- and post-construction modeling, including hydrodynamic modeling.	X				
	• Install a temporary tide gage in the early design stages to obtain site-specific tidal statistics.	X				
Geomorphic Analysis	• Complete a geomorphic analysis of channel migration potential to consider channel response to dike setback and increased tidal influence and fine tune channels and breaches.		X	X		X
Hydraulic Analysis/Modeling	• Implement a revised hydraulic model for the Skagit River reflecting the proposed geometry and the levee setback to predict the with-project water surface profiles and confirm the extent and nature of hydraulic effects from the project.		X	X	X	X
	• Combine review of aerial photographs with field surveys to quantify channel topology and hydraulic roughness and inform geomorphic evaluation under restored conditions.	X				
	• Assess hydraulics at setback levee and effects of increased tidal prism to optimize levee design and quantify effects on adjacent shores.		X	X		

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Hydraulic Analysis/Modeling (cont.)	• Evaluate changes in salinity and flow patterns within, adjacent to and downstream of the site, if required.			X		X
	• Review the potential effects on water wells, septic systems, and groundwater seepage in the area of potential hydraulic effect.		X			
	• Formulate the detailed monitoring plan, including any required field surveys or instrumentation that will be used to evaluate the project's hydraulic performance.			X		X
Sedimentation Analysis/Modeling	• Analyze potential channel infilling and evolution of interior channels to refine channels dimensions and determine long-term stability of the site. This will likely require a sediment model.		X	X	X	X
	• Design erosion control and slope protection for the setback levee. Assess whether erosion control or slope protection is needed in or adjacent to the site because of flow changes caused by the restoration.		X			
	• Evaluate temporary increases in sedimentation upstream and downstream of the site during the formation of any new distributary channels.		X			
Coastal Engineering Studies	• Refine sea level projections using localized tide gauge data.	X				
	• Review and establish the final design tidal datums		X			
	• Conduct wind direction and wave run-up analysis.		X	X	X	
Geotechnical Investigation	• Complete a standard investigation to include subsurface explorations, testing, and field reconnaissance.	X	X			
	• Confirm borrow and disposal sites.	X				
	• Analyze levee design stability, settlement, and seepage.		X		X	X
Excavated Materials Study	• Evaluate the suitability of excavated materials for reuse.	X	X			
Structural Engineering	• Structural analysis of the bridge, bridge piers, and foundation.		X			

Type	Basic Requirements	Purpose				
		Required Data	Design/Costs	Design/Benefits	Inundation	O&M
Structural Engineering (cont.)	• Analysis for gravity, wind and seismic effects.		X			
	• Design of bridge deck and supporting structure for gravity, wind and seismic effects in accordance with criteria established in this report.		X			
Utility Survey	• Compile more detailed information on utilities to finalize the design and confirm acquisition requirements.	X	X			
Cultural Resources Investigation	• Complete surveys for archaeological and historic resources, particularly in areas proposed for excavation.	X	X	X		
Wetlands Investigation	• Document the location, extent, and character of wetlands.	X		X		
Cost Study	• Assess potential for cost and schedule reductions during refinement of restoration design.		X			
Environmental Compliance	• The Corps will coordinate with all relevant natural resource agencies during PED. Results of PED-phase studies will be provided to agencies and tribes as appropriate.			X		

3-22 DATA MANAGEMENT

Project documents, background materials, and digital files from the local sponsors were provided to the project team directly, through the State's Habitat Work Schedule, or via the Nearshore Sharepoint. The project team also used databases previously developed by and for the Puget Sound Nearshore Ecosystem Restoration Project including the Change Analysis and backing geospatial data (see Section 3-3.1.1 for additional detail).

Work products for the conceptual restoration designs were developed primarily in GIS and typical word processor and spreadsheet applications. GIS products for all action areas were collected in a single geodatabase that captured spatially referenced locations and sizes of major design elements.

3-23 USE OF METRIC SYSTEM MEASUREMENTS

This report uses United States customary units for design and construction measurements. To remain consistent with work conducted to date, the metric system of measurement was not used.

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ANNEX 3-1: EXHIBITS

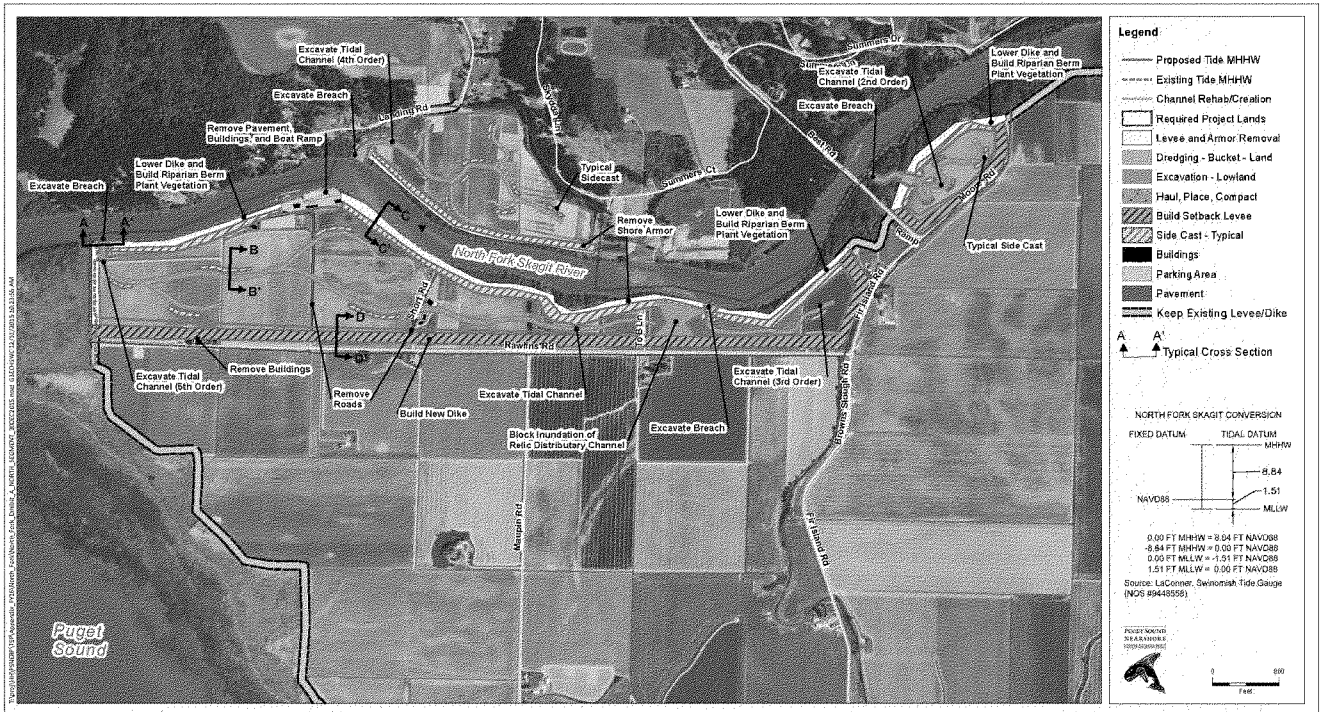
This annex contains a set of site-specific exhibits prepared for the proposed restoration. The exhibits include:

Exhibit A – Design Plan

Exhibit B – Design Sections

Exhibit C - Phase 1 Environmental Site Assessment

Exhibit A

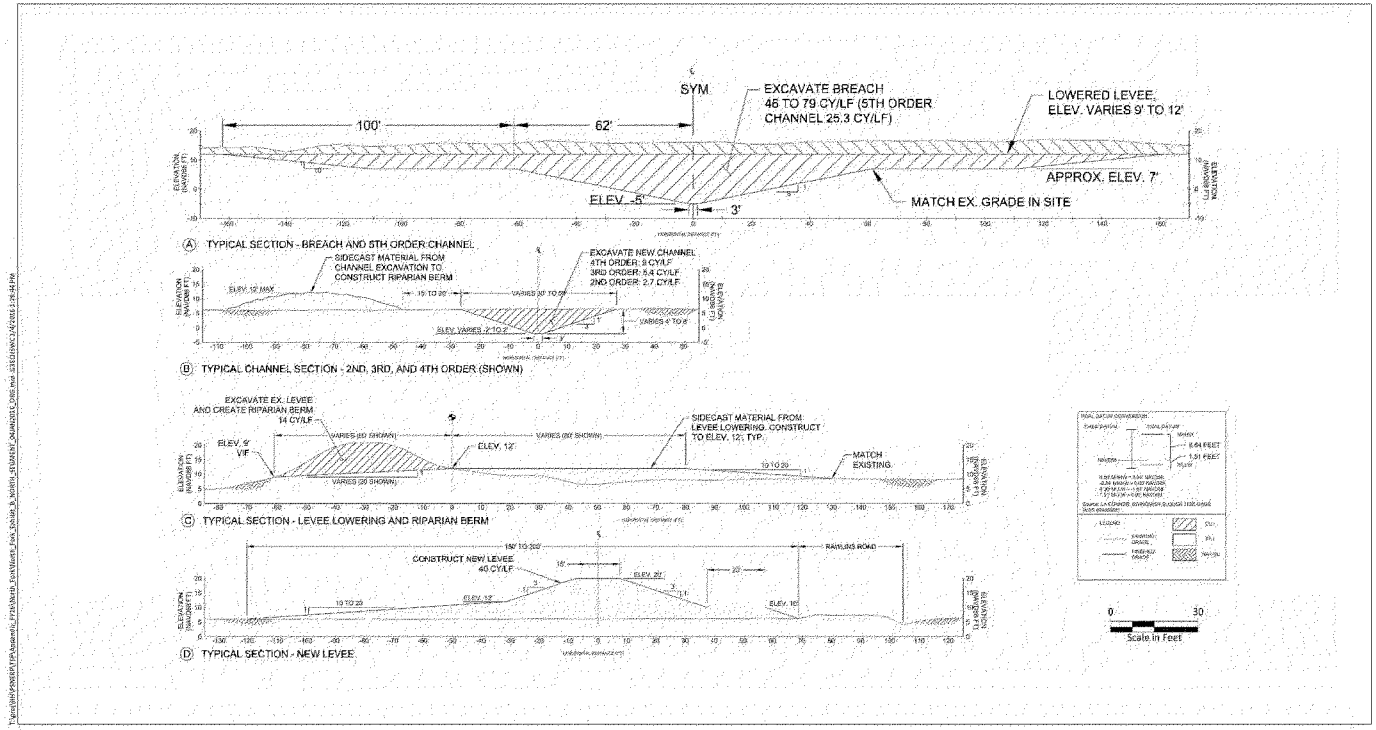


ORTHO_2013_NAIP_WASHINGTON

Site Name: North Fork Skagit River Delta

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit B



ORTHO_2019_NAIP_WASHINGTON

Site Name: North Fork Skagit River Delta

Lead Contractor: ESA
Design Lead: Anchor QEA, G. Sassen, ASLA
Revised: USACE Petroff/Campbell December 2015

Exhibit C

Puget Sound Nearshore Ecosystem Restoration Project
Feasibility Study
Hazardous, Toxic, and Radioactive Waste
Phase 1 Environmental Site Assessment

EXECUTIVE SUMMARY

The Seattle District Corps of Engineers (Corps), working collaboratively with the Washington Department of Fish and Wildlife (WDFW) as local sponsor, along with many other regional partners, has conducted a General Investigation (GI) to evaluate problems and potential solutions of ecosystem degradation and habitat loss in Puget Sound, Washington. The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). The Corps and local sponsor are recommending implementation of restoration actions at three sites throughout the study area as the outcome of the Nearshore Study. Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, the U.S. Army Corps of Engineers is preparing an Integrated Feasibility Report/Environmental Impact Statement (FR/EIS) for the three restoration actions. The Phase 1 Environmental Site Assessment for the North Fork Skagit site is being conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects,* except where noted below.

This assessment has revealed one potential recognized environmental condition in connection with the proposed project footprint, known as the Rexville Grocery site. However, due to the contaminants involved, degradation rates of those contaminants, topography, and the half mile distance between the Grocery and the subject property, this site is not expected to interact in any way with the proposed project. As a result, this assessment has revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site.

Puget Sound Nearshore Ecosystem Restoration Project
Feasibility Study
Hazardous, Toxic, and Radioactive Waste
Phase 1 Environmental Site Assessment

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1.0 INTRODUCTION

1.1 Involved Parties

The Corps is the lead Federal agency for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Report. The non-Federal, cost-sharing sponsor is the Washington Department of Fish and Wildlife (WDFW). As the non-Federal sponsor, WDFW contributes 50 percent of the total feasibility study costs in the form of cash or in-kind contributions; a feasibility cost sharing agreement was executed in 2001, with amendments.

1.2 Authority

The Puget Sound Nearshore Study (Nearshore Study) is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874).

1.3 Guidance and Policy

Corps policy providing guidance for consideration of issues and problems associated with hazardous, toxic, and radioactive wastes (HTRW), as defined in this regulation, which may be located within project boundaries or may affect or be affected by Corps Civil Works projects is contained in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects*, which defines HTRW as "...any material listed as a 'hazardous substance' under the Comprehensive Environmental Response, Compensation, Liability Act (CERCLA)". ASTM International (ASTM) Standard E 1527-13 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* provides a comprehensive guide for conducting an HTRW Assessment. An assessment identifies known or suspected releases of hazardous snbstances (recognized environmental conditions) based on records review, site visit, and interviews.

1.4 Scope of Work

The complete investigation serves to identify any recognized environmental condition, as defined in ASTM Standard E 1527-13. This site assessment documents known and suspected HTRW sites discovered through a search and review of all reasonably attainable federal, state, and local government information and records. A site visit, interviews with relevant stakeholders, and review of aerial photographs are also mandated under the above standard.

1.5 Significant Assumptions

This report identifies known and suspected environmental concerns, both past and present based on availability of information at the time of the assessment. It is possible that unreported disposal of waste or illegal activities impairing the environmental status of the properties may have occurred which could not be identified.

1.6 Limitations and Exceptions

This assessment deviates slightly from the exact procedures outlined in ASTM E1527-13. Specifically, no "User Provided Information" nor "Non-Scope Services" were provided, and those sections of the report were omitted. Also, due to the layout of the overall document to which this report will be incorporated, it was decided that no appendices were to be generated for this report. Additionally, it should be noted that portions of this report were conducted by separate agency entities that did not have the ability to coordinate their efforts.

1.7 Special Terms and Conditions

No special terms or conditions with respect to ER 1165-2-132 and ASTM E 1527-13 standards were made.

1.8 User Reliance

In accordance with ASTM E 1527-13 Section 7.5.2.1 "Reliance," the environmental professional is not required to independently verify the information provided by various sources but may rely on the information unless there is actual knowledge that certain information is incorrect or unless it is obvious that certain information is incorrect based on other information obtained during the course of the investigation or otherwise actually known to the investigators conducting the assessment. At the present time there is no indication that the information provided by the database search is incorrect.

2.0 SITE DESCRIPTION

2.1 Location and Legal Description

The "property", as defined by the referenced ASTM standard, in this case includes several different properties on the southern bank on the North Fork Skagit River. For the purposes of this assessment, the proposed North Fork project footprint will serve as the "property" under review (See Figure 6-6 in the main body text of the feasibility report).

2.2 Site and Vicinity General Characteristics

The physical setting of the subject property and vicinity is detailed in Section 6.1.3 of the main feasibility report.

3.0 RECORDS REVIEW

3.1 Standard Environmental Records

A records search was conducted on May 13, 2014 and on November 2, 2015 using a variety of sources. These sources included EPA's National Priority List Mapper, EPA's EnviroFacts database, the Washington State Department of Ecology's (Ecology) Toxics Cleanup Program (TCP) database, and Ecology's Facility/Site database. Below are the parameters and results of the records search.

Parameter	Source	Minimum Search Distance (mi.)	Results
Federal NPL	EPA NPL Mapper	1	None
Federal Delisted NPL	EPA NPL Mapper	0.5	None
Federal CERCLIS	EnviroFacts	0.5	None
Federal RCRA Generators	EnviroFacts	Property and Adjoining Properties Only	None
Federal RCRA TSDs	EnviroFacts	0.5	None
Federal RCRA Corrective Action Sites	EnviroFacts	1	None
Federal and State ICs Registry	Ecology TCP	Property Only	None

Parameter	Source	Minimum Search Distance (mi.)	Results
Federal Toxic Release Inventory	EnviroFacts	0.5	None
State and Tribal Cleanup Sites	Ecology TCP	1	1 finding (Rexville Grocery)
State and Tribal Landfills and/or Solid Waste Disposal Facilities	Ecology Facility Search	0.5	None
State and Tribal UST Registry	Ecology TCP	Property and Adjoining Properties Only	None
State and Tribal LUST	Ecology TCP	0.5	1 finding (Rexville Grocery)
State and Tribal Brownfields	Ecology TCP	0.5	None

The records search did not identify any known or suspected contaminant releases within the project footprint. Ecology lists one state cleanup collocated with one leaking underground storage tank within a half mile of the project boundaries, known as the Rexville Grocery or the Little Country Store. Further investigation revealed that the leaking underground storage tank was reported as cleaned up in 1993, with 30 cy of contaminated soil being disposed of as well. However, Ecology could not verify the completeness of the cleanup and as a result, the site is still on Ecology's cleanup list. As of 2015, additional investigations by the State may occur. Despite the presence of this site approximately a half mile from the subject property, the proposed project would not affect, nor be affected by the Rexville Grocery cleanup investigation due to its distance from the project footprint. Additionally, the volatilization/degradation rates of the contaminants spilled (in this case gasoline and associated byproducts) over the course of 22+ years means there is an extremely low likelihood of these substances remaining in the groundwater in reportable quantities, much less migrating the half mile distance to the proposed Corps project. Finally, the topography of the area uorth of the river is not conducive to rapid groundwater flow into the proposed Corps project. No other sites of concern were noted during the records search.

3.2 Historical Records

A review of aerial photographs spanning 75 years show no major changes to land use on the subject property or its surroundings. The land is almost completely agricultural, with no intensive excavation noted, and no industrial activity present in the area.

3.3 Additional Environmental Record Sources

There are no additional environmental record sources included in this assessment.

4.0 SITE RECONNAISSANCE

A site visit was conducted by the USFWS in October 2010. The action area is currently owned by multiple landowners, and used primarily for agricultural purposes. The site visit noted the presence of several

households, farms, and/or debris locations, but these were not accessed. Adjacent to the action area is an active RV/resort and boat launch, several transmission lines, and various roads. There is fill in the action area associated with existing levees, roads, and residences in the floodplain. There is likely other farming or residential debris, along with machinery and equipment repair areas on individual landowner properties. A visual survey of the action area revealed no known or suspected contaminant releases or spills. However, the Phase I site visit did not visit all parts of the action area, due to private property restrictions.

An interview was conducted with Mr. Stan Nelson of the Skagit County Diking District #22 on February 17, 2011 by telephone. No record of this interview exists, other than a statement that indicated the possibility of a former Skagit County garbage dump to the west of Brown's Slough Road (now called Fir Island Rd.). This site was not identified in the record search and not much is known about the status of the site, including its exact location. On October 13, 2015, a phone call was placed to Ms. Britt Pfaff-Dunton of the Skagit County Environmental Health Department to follow up on this anecdotal evidence. The respondent stated that while it was not uncommon for farmers to dispose of their trash and agricultural debris in Brown's Slough, Skagit County records show no historical landfills on Fir Island. Review of all available documentation did not identify the alleged landfill, and a review of historical aerial photographs show no evidence of the landfill or any dumping of any kind. Therefore, there are no suspected releases as a result of this alleged landfill.

5.0 FINDINGS AND CONCLUSION

This Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments*, and ER 1165-2-132: *HTRW Guidance for Civil Works Projects*. The assessment was initially conducted in 2010 by Ginger Phalen, biologist with the USFWS, and updated in 2015 by David Clark, remediation biologist at the U.S. Army Corps of Engineers (Corps).

This assessment has revealed one potential recognized environmental condition in connection with the proposed project footprint, known as the Rexville Grocery site. However, due to the contaminants involved, degradation rates of those contaminants, topography, and the half mile distance between the Grocery and the subject property, this site is not expected to interact in any way with the proposed project. As a result, this assessment has revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site.

6.0 SOURCES

ASTM E1527-13: *Standard Practice for Environmental Site Assessments.*

Engineer Regulation 1165-2-132: *HTRW Guidance for Civil Works Projects.*

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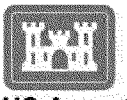
Attachment A – Cost Annex



US Army Corps
of Engineers®

COST ANNEX
FOR
Puget Sound Nearshore Ecosystem Restoration Project
Puget Sound, WA

Prepared for:

Seattle District, Seattle, WA

Prepared by:

USACE, Seattle District

Date: June 08, 2016

INTRODUCTION

The purpose of this appendix is to document and present the detailed cost estimate prepared in support of the Puget Sound Nearshore (PSNERP) GI. The project is intended to restore a more natural hydrology and environment at project sites throughout the Puget Sound. These individual projects are scattered throughout the Puget Sound, and the scope of work varies widely between them. The local sponsor for this project is the Washington State Department of Fish & Wildlife.

The basis of the cost estimates is conceptual design drawings and conceptual quantities prepared by the Project Delivery Team (PDT). Additional information developed by the PDT is incorporated into the estimate. This includes emails, phone calls, and in-person discussions. The MCACES estimate documents the basis of information used in development of costs, down to the lowest reasonable level. Guidance for preparation was obtained from ER 1110-2-1150 Engineering and Design (E&D) for Civil Works Projects, ER 1110-1-1300 E&D Cost Engineering Policy and General Requirements, ER 1110-2-1302 Civil Works Cost Engineering, and ETL 1110-2-573 E&D Construction Cost Estimating Guide for Civil Works. The cost estimates were prepared using Micro-Computer Aided Cost Estimating System MII version 4. Supporting cost libraries or databases were MII 2012-b English Cost Book, 2014 Region VIII Equipment library (EP 1110-1-8) and the 2015 National Labor Library rates for Seattle, Washington. Fuel rates were obtained online from gasbuddy.com.

The cost estimate was prepared at a level commensurate with the level of design detail, which should be considered a budget or class III estimate. Substantial additional design will be required at all sites that are contained within the PSNERP footprint.

Uncertainties regarding the cost estimate are documented in the Cost and Schedule Risk Analysis (CSRA) risk register report and based on a Formal risk analysis suitable for this stage in the planning process.

Quantities used in the cost estimate came from two sources: primarily they were developed by the applicable designer and delivered to the cost engineer, who then validated that they are reasonable. Additionally, limited quantities were developed by the cost estimator to support the estimate.

Lastly, this is a cost share project with the Washington State Department of Fish & Wildlife (WDFW) as the Local Sponsor. Federal costs are anticipated to be 65% of the Total Project Cost of the restoration features, with the balance to be WDFW's share.

PRICE LEVEL

The three categories of cost contained in the Total Project Cost Summary (TPCS) are "Estimated Cost," "Project First Cost," and "Total Project Cost." The estimated cost,

which is the cost calculated in MCACES (MII), is based on a price level of October 2015. The Project First Cost, or in other words the value the project is actually authorized at, is also set at October 2015. Lastly, the date point of the Total Project Cost which is the cost the government will pay at the year of construction varies from 2020 to 2028. The sites are expected to be constructed over a period of decades and each site will have its own midpoint of construction.

Escalation is based on the September 2015 Civil Works Construction Cost Index System (CWCCIS), EM 1110- 2-1304.

It is assumed that the Seattle metropolitan area possesses a sufficiently large and diverse enough contractor, labor, equipment, and material base to support the project. The potential that this is not the case is considered within the risk analysis. Sources of cost information include MII 2012-b English Cost Book, 2014 Region VIII Equipment library (EP 1110-1-8) and 2015 Davis Bacon wage rates for Skagit County , Washington. Additionally, local vendor quotes for critical items were solicited and utilized for major components, or items that would otherwise be difficult to account for.

The cost of the selected plan is considered fair and reasonable, provided the construction is done by a prudent and well equipped contractor.

COST ESTIMATE STRUCTURE

The cost estimate for the project was prepared by the Cost Engineering Section within Seattle District. The overall structure of the cost estimate is dictated by the Civil Works – Work Breakdown Structure. This structure is followed down to the sub-feature level (e.g. feature 11 Levees and Floodwalls, followed by sub-feature 1101 Levees.) The remainder of the estimate structure is based on the expected construction methodology and phasing techniques as determined by the PDT.

A site specific discussion regarding cost, schedule, and risk is included within the Engineering Appendix. What follows is a discussion regarding the methodology used in estimate development throughout the program.

Project features in the total project cost summary (TPCS) are in accordance with the CWWBS:

01 Lands and Damages include the real estate acquisitions of project lands, easements and rights-of ways and PL 91-646 relocation costs. Additional real estate costs include: non-Federal's sponsors cost for land surveys, title preparation, legal opinions and Federal costs of reviewing the non-Federal sponsor's documents for legal sufficiency.

02 Relocation costs include new construction to modify existing public infrastructure. This will include the cost to construct new roads, bridges, levees and utilities All

demolition costs for existing infrastructures was determined to be a general construction cost and was assigned to the appropriate WBS item.

06 Fish & Wildlife Facilities. Since the main purpose of this project is ecosystem restoration all construction features not captured in 02 Relocations are summarized under WBS 06. This is reflected in the summary sheet of the TPCS, where 08, 09 & 11 project features are rolled into the 06 WBS item.

Typical 06 project features include efforts such as plantings, placement of large woody debris, removal of environmental stressors, and filling of agricultural ditches that prevent natural processes.

While not separately given their own line in the top sheet of the TPCS, Adaptive Management and Monitoring are both funded under WBS 06, and are explicitly noted for each project site. These are separately accounted for in MCACES, as they are based on scope provided by the PDT. Both of these are allowed under ER 1105-2-100 Sec. 3-5.b.(8). Implementation Guidance issued August 31, 2009 for Section 2039 of WRDA 2007 requires these activities be done, and that Monitoring can be cost shared for 10 years following construction completion.

Roads, Railroads & Bridges. While not separately given its own line on the summary sheet of the TPCS this project feature still captures construction costs in the supporting pages of the TPCS and the MCACES report. This includes all work to create new roadways such as pavement, earthwork shaping, guardrails and stripping. As well all work to create bridges including temporary access, bridge construction and bridge demo is also captured here.

Channels & Canals. While not separately given its own line on the summary sheet of the TPCS this project feature still captures construction costs in the supporting pages of the TPCS and MCACES report. This accounts for all costs to create tidal channels and canals that will restore areas to a more natural wetland state.

Levee and Floodwalls. While not separately given its own line on the summary sheet of the TPCS this project feature still captures construction costs in the supporting pages of the TPCS and MCACES report. Includes costs for demolition, installation, breaching, and lowering of all levees within a site. Other incidentals such as levee armoring are also accounted for here.

18 Cultural Resource Preservation. Includes calculated costs for work related to site surveys. These surveys may be done by the contractor and would evaluate historical structures and archaeological elements at the site. At the requirement of the Planning Team, an additional amount to account for Cultural Resource data recovery was included. This is allowed per ER 1105-2-100 App C C-4.d (10). The amount selected was 1% of all construction costs (not including PED, CM, Monitoring, or Adaptive Management) and is accounted for under the TPCS. Similar to Adaptive Management and Monitoring, this 1% additional cost is accounted for only within the TPCS. MCACES contains calculated values that

cover surveys, analyses, and reports, however, the 1% of construction costs is in addition to that.

30 Planning, Engineering and Design (PED). Provides the estimated engineering design costs for each project. In consultation with the Project Manager, three ranges for PED costs were determined based on the construction cost of the project. These categories were: projects between $0.1M and $10M, $10.1M to $99.9M, and $100M to $500M. Projects at the upper and lower ends of the spectrum had PED costs based on lump sum values, while those ranging from $10.1M to $99.9M had costs based on percentages. In general, design costs are somewhat correlated to project cost (as projects cost more, they are typically more complex). However, for lower construction cost projects, design cost estimates may under calculate the amount of work required, while for larger projects they may over calculate. Thus, set values were used for these extremes.

31 Construction Management (CM) provide the estimated CM or Supervision and Administration costs based on a percentage or lump sum of the construction cost features. The ranges used for this are identical to those used in 30 PLANNING, ENGINEERING, & DESIGN.

PROJECT CONTINGENCY

Contingencies are added to the cost estimates in the TPCS based on the results of the cost and schedule risk analysis performed in 2015. Further information about the CSRA can be found in the CSRA Report. The overall contingency of the project is 38.8%. Contingency values vary between sites but encompass a range of 36% to 46%. Results of the cost risk study yielded a percent contingency which has been added to the construction costs of the project. This value is not separate and distinct from the base cost of the project, but is a key component of it. As the project is developed, it is expected that the calculated cost of various features will increase as more becomes known regarding the sites. As more detail is available, contingency will be reduced as uncertainty and risk are lowered.

PROJECT ESCALATION

Escalation factors to the Effective Price Level Date and the Fully Funded Project Estimate Amount through the end of construction have also been included as part of the TPCS. The inflation was based on an assumed authorization date of October 1, 2015 and a mid-point of construction that varies between projects (2020-2028).

The date of authorization and schedule of projects are assumptions. If the date of authorization is delayed, the overall project schedule will be delayed. Similarly, the

project schedule could be extended if funding does not match the original expectations.

PROJECT ASSUMPTIONS

At this phase of design there are still many unknowns and data gaps that won't be resolved until the project reaches the PED phase. Many assumptions were made and coordinated with the PDT to account for the design limitations. All assumptions were made with a slight conservatism already built in, knowing full well that a formal cost and schedule risk analysis would be used to capture the project contingency.

Key assumptions made while preparing construction costs:

- Disposal points for rock, fill, and construction debris are available within 30 miles for Nooksack and North Fork and within 60 miles for Duckabush.
- Sources of rock, fill, and general construction materials are available within 30 miles for Nooksack and North Fork and within 60 miles for Duckabush.
- Levee construction will require entirely new fill.
- Levees that are removed will have their fill disposed of off-site, unless explicitly noted otherwise.
- Existing roads and utilities will be replaced "in-kind" where demolished except for North Fork. Any changes in design codes must be incorporated when constructing new public infrastructure. However, if an existing road is two lanes, it will not be replaced with a four lane highway.
- All property acquisitions and easements can be achieved.
- There is sufficient workforce and equipment available to complete the project within the calculated timeframe.
- Work on any site within the PSNER Program will be performed entirely by one Prime Contractor, with multiple sub-contractors. All work will occur under one contract per site.
- Sub-contractors are assumed to do all non-supervisory work. This minimizes risk of alternate contracting arrangements.
- Staging areas are available close to the project elements.

Many of these assumptions were made by the PDT as a whole, but as they have significant cost impacts they are listed above.

DEVELOPMENT OF COSTS BY FEATURE

GENERAL

Most design information for PSNERP originally came from an Architect-Engineer hired by the Washington Department of Fish and Wildlife. A detailed discussion of this information was verified and updated is available in the appropriate Design

appendices.

Quantities for each site are accounted for in the MII Estimate for each respective site. Note that there are variations and differences from the Quantity Estimates provided by the A/E that are accounted for in the estimate. This is done based on the USACE design team spot checking quantities and in some cases revising quantities based on current conditions and design standards.

Following is discussion of how the costs for each feature of work were developed.

01 REAL ESTATE

Real estate acquisition costs along with relocations costs and internal administrative costs for land purchases and easements were provided to the Cost Engineer by Diane Hintz (NWS Real Estate). Real Estate provided their own contingency on such costs. Note that contingencies are not broken out separately in the TPCS for 01 REAL ESTATE. Please see the real estate appendix for further information.

02 RELOCATIONS

Relocations costs for each site were considered on a case by case basis. For each site, all features of work were evaluated to determine if it would be considered a relocation costs. Office of counsel, the Project Manager and Planner were involve in this discussion. Features of work that are typically considered for relocation costs are roads, bridges, levees and utilities. More specifically the cost for new construction was deemed a relocation cost. The demolition of such features of work was assigned to either WBS 06, 08, 09 or 11.

06 WILDLIFE FACILITIES & SANCTUARY

Quantities and rough scopes of what work will occur was provided by NWS Civil Design while being coordinated with NWS Environmental and Cultural Resources Branch (ECRB). For example, while vegetation areas were provided by Civil Design, the plant mix and spacing was provided by ECRB. Other elements, such as the large woody debris, were based on designs from other projects. Costs for this feature come from vendor quotes, RS Means items, and estimator judgment related to productivity. This account encompasses the widest array of different activities, but one feature that is consistent across most sites is building demolition. Little is known about the various structures being demolished within the project sites. Single story steel framed buildings were assumed, and the fact that this is likely to vary is considered in the risk analysis.

Plantings were given to Cost Engineering as an area, and a template plant spacing and species mix was provided by ECRB. A riparian mix was developed for upland areas, and a saltwater plantings mix was developed for areas that would be inundated.

ROADS, RAILROADS & BRIDGES

Information regarding road removal and installation, utilities, bridges, and railway construction activities would be done was provided to Cost Engineering by NWS Civil Design. Bridge information was coordinated with NWS Structures and NWS Geotechnical Design. Subsequently installation costs were developed based on RS Means production rates, custom crews and production rates based on site specific constraints, and vendor quotes for materials. Bridge design information was limited for the project and a standardized model was developed and used in all locations where road or rail bridge construction occurred.

This standardized bridge model includes large caissons being drilled to their appropriate depth, piers being installed, and heavy use of cranes to set girders into place. For new roads, 10" asphalt on top of 12" of crushed rock is assumed. Road construction includes crews to demo and replace hot mix asphalt, place pavement marking, provide traffic control and survey the site.

CHANNELS & CANALS

Quantities and rough scopes of what work will occur was provided by NWS Civil Design. Limited hydraulic design work was done by NWS Hydraulics and Hydrology (H&H) Branch. Excavation is done by tracked excavator or backhoe and is either side cast in low berms, used elsewhere on-site, or hauled to an off-site disposal facility. The channels are shallow and two cubic yard excavators are typically used.

LEVEES AND FLOODWALLS

Quantities and rough scopes of what work will occur was provided by NWS Civil Design. Fill material costs are based on vendor quotes (note that all fill is assumed to be purchased), and production rates and crew composition is based on RS Means items or calculated by the cost engineer. In certain areas, protective rip rap will be placed to armor the riverward slope. All grading information was developed from LIDAR surveys and contains a relatively high amount of uncertainty. This uncertainty is discussed and evaluated as part of the Cost & Schedule Risk Analysis.

Existing levees are either lowered by scrapers or excavators, and breaching is done by excavators. Levees that are breached typically are on islands and have their excess material graded out on-site in order to allow natural flow. New levee construction is done by crews consisting of excavators, dozers, and roller compactors that shape the levee into the proper prism.

Unusual construction methodologies or problematic design conditions were not assumed in the estimate. Settlement during or shortly after construction was not assumed to be an issue at project sites. The PDT does recognize that these issues are likely to occur at some of the projects, but lacked sufficient information to make a determination. The possibility that this will occur is evaluated in the Cost & Schedule Risk Analysis.

18 CULTURAL RESOURCE PRESERVATION

Requirements were specified by NWS Environmental and Cultural Resources Branch. Includes time for survey, analysis of each site and report preparation.

PROJECT SCOPE

The purpose of this project is to address and restore ecosystems through restoration of natural processes and restoration and/or re-creation of coastal wetlands and embayments. There are three sites in the recommended plan with locations throughout the Puget Sound. Restoration actions will occur near the mouth of the Duckabush River, Skagit River and Nooksack Rivers, respectively.

The proposed action to the Duckabush River Estuary would restore the natural geomorphology by removing major roadway obstructions, excavating channels, and removing fill. The action would remove two bridges that total 970 LF and associated approach road embankments along Highway 101. This will be followed by realigning Highway 101 onto a new 2100 LF bridge across the estuarine delta to restore tidal connection to the estuary. A surface street crossing (Shorewood Road) would be modified to tie into the new bridge structure. Adjacent fill at a distributary channel (Pierce Slough) would be removed. Multiple tidally influenced distributary river channels summing to 1,155 LF would be reestablished, and blind tidal channels summing to 4,200 LF would be excavated within the marsh areas.

The proposed action to the Nooksack River Delta would restore riverine and tidal flow as well as sediment transport and delivery processes throughout a substantial portion of the historical Nooksack River delta. This will be accomplished by a combination of construction features that would modify levees, roads, and other hydrological barriers. Construction of approximately 47,000 LF of new setback levees would provide flood risk management protection for active businesses, residences, farms, transportation infrastructure, and Lummi Nation lands in the project area. Features of work associated with levee setback construction include but are not limited to: 12,280 LF of levee removal, installation of 3 log jam structures, installation of 1 new water control structure and 9,980 LF of channel and berm regarding. Construction on existing infrastructure includes but is not limited to: removal of 6 bridges and approach road section and construction of 6 new bridges and approach road sections.

The proposed action to the North Fork Skagit River Delta would restore the riverine floodplain and tidal connectivity along the lower reach of the North Fork of the Skagit River. This will require constructing a new 12,300 LF flood risk management levee further inland. The 15,700 LF existing levee would be lowered and selectively breached in 4 locations to allow inundation of the estuarine emergent marsh and sustain back channel habitat. Forested floodplain habitat would be created along the lowered levee adjacent to the mainstem river channel. This will be done by excavating and creating 39,200 LF of

tidal channels, removing 17 buildings in the flood plain, removing 344,300 SF of existing road and plant riparian vegetation over approximately 50 acres.

CONTRACTOR AND INDIRECT COST CONSIDERATIONS

The cost estimator assumed the work is done by a prime contractor who will subcontract most of the construction work. The reasoning for this is that the smaller locations are likely to be managed by Small Business contractors, and the larger ones are likely to be broken up into many smaller contracts.

Assuming a large contractor will be performing this work would be a very risky assumption. Contract acquisition strategy will be an important aspect of the PED phase. Specialty activities such as concrete placement, paving, and electrical/mechanical work are to be done by subcontractors hired by the prime contractor. No more than one level of sub-contractors is presently assumed. This arrangement makes for up to two levels of contracting and markup costs (job office overhead, home office overhead, profit, bond, and B&O tax).

PLANNING, ENGINEERING, AND DESIGN

The Planning, Engineering and Design (PED) costs are the costs from authorization until the site specific construction contract is awarded. This work includes detailed surveys, soil investigations and preparation of the plans and specifications to guide the contractor to construct the project. As noted above these values are established based on project sizes with three separate tiers.

CONSTRUCTION MANAGEMENT

The Construction Management (CM) costs are determined as a percent of the estimated construction costs. Similar to PED funding, this was broken into three tiers. The Planner in coordination with Cost Engineering selected a 9.5 percent contingency.

CONTINGENCY

Current regulations require analysis of schedule and costs risks. See the C&SRA Report Attachment for the Formal Cost Risk Analysis Study (C&SRA) documentation that was performed in 2012, and reevaluated in 2014 and 2015. The results of the cost risk study was a 38.8 percent project contingency (based on the 80% confidence

interval) was appropriate for construction costs. A formal Monte Carlo simulation was done for each project site as required.

Contingency for 01 Real Estate costs was determined by NWS Real Estate. These values depend on the specific site and are available in the Real Estate Annex.

An output of the risk analysis is contingency, whose purpose is an added cost included in the cost estimate to cover unknowns. Risk drivers vary across the project, but certain elements were common across the project.

Unknowns across the project could include:

- Earthwork quantities were considered very speculative given the limited amount of design information available and the limited resolution of the LIDAR surveys. Variations of 20% could occur where levees and other major earthwork construction occurs.
- The bridge construction model used across the project utilizes a number of assumptions and there could be significant cost increases if these change during later design.
- A common assumption across all projects is that one Prime Contractor will be responsible for all construction. This was done to ease the estimating process and since there is not a way at present to determine how these will be contracted. It is likely that these sites will be split into two or more contracts. The risk to the base construction cost is relatively low: JOOH is calculated based on a percentage of the project cost and is not dependent on schedule, and sub- contractors are assumed to do all work on a site. However, there would be substantial impacts to overall project schedule.
- The available information on existing roads is minimal and there is a large degree of uncertainty as to what the existing roads are like and what exact changes will need to be made to accommodate new and raised levees. While the construction required for roads is well understood, additional detail will be needed related to items such as road width, depth of base and HMA, as well as how much road will be need to be relocated. This also applied to utilities, as information available was minimal at best.
- There may be difficulties in dealing with the large number of entities that will be affected by the project. State and federal highways, railroad mainlines, local utilities, and affected homeowner will all have concerns regarding project impacts to their property. This should not be viewed as a problem, as properly resolving stakeholder concerns is desirable. However, the scope and requirements of this is unknown, and may require extended time spent in the PED phase, or even changes to the project footprint to make reasonable accommodations.

PROJECT SCHEDULE

The overall project schedule and sequence was determined in coordination with Project Management. The anticipated sequence will start with Duckabush, followed by North Fork and finally end with Nooksack.

The site specific construction schedules were developed by the cost engineer based on MII calculated durations and logical sequencing of construction features. Project length depends upon the individual site and projected durations range from two to six years. Note that all durations are built on the assumption of a single contract, with concurrent construction activities. Breaking the contract into smaller elements would increase the duration.

Prior to construction start and after authorization, Planning, Engineering, and Design will occur. This is expected to take at least two years for Duckabush and North Fork and five years for Nooksack. PED will continue until all projects are contracted.

OPERATIONS, MAINTENANCE, REPAIR, REHABILITATION, AND REPLACEMENT COSTS

An OMRR&R estimate was prepared based on scope put together by the PDT. This cost is included in the TPCS as a stand-alone cost and does not roll up into the total project cost.

FINAL FEASIBILITY ESTIMATE

The final feasibility cost estimate as presented in the following Total Project Cost Summary (TPCS) for is as follows:

Cost of Puget Sound Nearshore Environmental Restoration Program
Washington State
2016 Feasibility Report

FY 2016 Price Level
$451,627,000
Fully Funded Amount
$539,839,000

Estimated Federal Cost
$350,896,000
Estimated Non-Federal Cost
$188,944,000

ATTACHMENTS

TPCS
MCACES REPORT
PROJECT SCHEDULES
CSRA REPORTS

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 106225

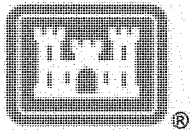
NWS – Puget Sound Nearshore Ecosystem Restoration Feasibility Report

The Puget Sound Nearshore Ecosystem Restoration - Feasibility Study, as presented by Seattle District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of June 8, 2016, the Cost MCX certifies the estimated total project cost of:

FY 2016 Price Level: $451,627,000
Fully Funded Amount: $539,839,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.



Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **Puget Sound Nearshore Ecosystem Restoration**
PROJECT NO: 106225
LOCATION: Washington State

DISTRICT: **NWS Seattle District** **PREPARED:** **3/15/2016**
POC: CHIEF, COST ENGINEERING, John Dudgeon

This Estimate reflects the scope and schedule in report; PSNERP Feasibility Report

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC):				2016					
						Effective Price Level Date:				1 OCT 15					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **10/1/2015** ($K)	**TOTAL FIRST COST** ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*			*M*	*N*	*O*	
02	RELOCATIONS	$91,818	$38,682	42.1%	$130,500	0.0%	$91,818	$38,682	$130,500	$0	$130,500	12.5%	$103,320	$43,520	$146,841
06	FISH & WILDLIFE FACILITIES	$128,945	$50,331	39.0%	$179,276	0.0%	$128,945	$50,331	$179,276	$0	$179,276	19.1%	$153,453	$59,985	$213,438
18	CULTURAL RESOURCE PRESERVATION	$4,467	$1,811	40.5%	$6,278	0.0%	$4,467	$1,811	$6,278	$0	$6,278	17.3%	$5,241	$2,125	$7,367
						-									
						-									
						-									
						-									
	CONSTRUCTION ESTIMATE TOTALS:	$225,230	$90,824	40.3%	$316,054	0.0%	$225,230	$90,824	$316,054	$0	$316,054	16.3%	$262,015	$105,631	$367,646
01	LANDS AND DAMAGES	$25,651	$5,338	20.8%	$30,989	0.0%	$25,651	$5,338	$30,989	$0	$30,989	10.1%	$28,262	$5,873	$34,135
30	PLANNING, ENGINEERING & DESIGN	$53,103	$21,456	40.4%	$74,559	0.0%	$53,103	$21,456	$74,559	$0	$74,559	26.6%	$67,265	$27,140	$94,405
31	CONSTRUCTION MANAGEMENT	$21,397	$8,628	40.3%	$30,025	0.0%	$21,397	$8,628	$30,025	$0	$30,025	45.4%	$31,109	$12,545	$43,655
	PROJECT COST TOTALS:	$325,381	$126,246	38.8%	$451,627		$325,381	$126,246	**$451,627**	$0	**$451,627**	19.5%	$388,651	$151,188	$539,839

_____ CHIEF, COST ENGINEERING, John Dudgeon

_____ PROJECT MANAGER, Lynn Wetzler

_____ CHIEF, REAL ESTATE, Patricia Fatherree

_____ CHIEF, PLANNING, Valerie Ringold

_____ CHIEF, ENGINEERING, JoAnn Walls

_____ CHIEF, OPERATIONS, Elizabeth Coffey

_____ CHIEF, CONSTRUCTION, Mark Slominski

_____ CHIEF, CONTRACTING, Dave Williams

_____ CHIEF, PM-PB, Valerie Ringold

_____ CHIEF, PPMD & DDEPM, Olton Swanson

ESTIMATED FEDERAL COST:	**65%**	**$350,896**
ESTIMATED NON-FEDERAL COST:	**35%**	**$188,944**
ESTIMATED TOTAL PROJECT COST:		**$539,839**
Estimated OMRRR (FY2016)		**$ 43,180**

Filename: PSNERP TPCS 6-8-16 FY 2016 - MCX CHECK.xlsx
TPCS

**** CONTRACT COST SUMMARY ****

PROJECT: Puget Sound Nearshore Ecosystem Restoration
LOCATION: Washington State
This Estimate reflects the scope and schedule in report; PSNERP Feasibility Report

DISTRICT: NWS Seattle District
POC: CHIEF, COST ENGINEERING, John Dudgeon

PREPARED: 3/15/2016

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 3/15/2016 Effective Price Level: 10/1/2015				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	Duckabush													
02	RELOCATIONS	$32,576	$14,985	46%	$47,561	0.0%	$32,576	$14,985	$47,561	2022Q1	12.2%	$36,538	$16,808	$53,346
06	FISH & WILDLIFE FACILITIES	$4,602	$2,117	46%	$6,719	0.0%	$4,602	$2,117	$6,719	2022Q1	12.2%	$5,162	$2,374	$7,536
06	MONITORING	$164	$41	25%	$205	0.0%	$164	$41	$205	2024Q1	36.8%	$224	$56	$280
06	ADAPTIVE MANANGEMENT	$1,473	$678	46%	$2,151	0.0%	$1,473	$678	$2,151	2024Q1	16.7%	$1,719	$791	$2,510
06	ROADS, RAILROADS & BRIDGES	$6,127	$2,818	46%	$8,945	0.0%	$6,127	$2,818	$8,945	2022Q1	12.2%	$6,872	$3,161	$10,034
18	CULTURAL RESOURCE PRESERVATION	$1,239	$570	46%	$1,809	0.0%	$1,239	$570	$1,809	2022Q1	12.2%	$1,390	$639	$2,029
	CONSTRUCTION ESTIMATE TOTALS:	$46,181	$21,209	46%	**67,390**		$46,181	$21,209	$67,390			$51,905	$23,829	$75,734
01	LANDS AND DAMAGES	$491	$63	13%	$554	0.0%	$491	$63	$554	2018Q4	5.1%	$517	$66	$583
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,155	$530	46%	$1,685	0.0%	$1,155	$530	$1,685	2018Q4	11.0%	$1,282	$589	$1,870
1.0%	Planning & Environmental Compliance	$462	$212	46%	$674	0.0%	$462	$212	$674	2018Q4	11.0%	$513	$235	$748
12.0%	Engineering & Design	$5,542	$2,545	46%	$8,087	0.0%	$5,542	$2,545	$8,087	2018Q4	11.0%	$6,150	$2,824	$8,975
1.0%	Reviews, ATRs, IEPRs, VE	$462	$212	46%	$674	0.0%	$462	$212	$674	2018Q4	11.0%	$513	$235	$748
0.5%	Life Cycle Updates (cost, schedule, risks)	$231	$106	46%	$337	0.0%	$231	$106	$337	2018Q4	11.0%	$256	$118	$374
1.0%	Contracting & Reprographics	$462	$212	46%	$674	0.0%	$462	$212	$674	2018Q4	11.0%	$513	$235	$748
3.0%	Engineering During Construction	$1,385	$636	46%	$2,021	0.0%	$1,385	$636	$2,021	2022Q1	26.1%	$1,747	$802	$2,549
2.0%	Planning During Construction	$924	$424	46%	$1,348	0.0%	$924	$424	$1,348	2022Q1	26.1%	$1,166	$535	$1,701
1.0%	Project Operations	$462	$212	46%	$674	0.0%	$462	$212	$674	2018Q4	11.0%	$513	$235	$748
31	CONSTRUCTION MANAGEMENT													
5.0%	Construction Management	$2,309	$1,060	46%	$3,369	0.0%	$2,309	$1,060	$3,369	2022Q1	26.1%	$2,913	$1,338	$4,250
2.0%	Project Operation:	$924	$424	46%	$1,348	0.0%	$924	$424	$1,348	2022Q1	26.1%	$1,166	$535	$1,701
2.5%	Project Management	$1,155	$530	46%	$1,685	0.0%	$1,155	$530	$1,685	2022Q1	26.1%	$1,457	$669	$2,126
	CONTRACT COST TOTALS:	$62,145	$28,378		**$90,523**		$62,145	$28,378	$90,523			$70,609	$32,248	**$102,856**
	OMRRR	$4,178	*$1,919*	*46%*	***$6,097***									

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Puget Sound Nearshore Ecosystem Restoration
LOCATION: Washington State
This Estimate reflects the scope and schedule in report; PSNERP Feasibility Report

DISTRICT: NWS Seattle District
POC: CHIEF, COST ENGINEERING, John Dudgeon

PREPARED: 3/15/2016

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 3/15/2016 Effective Price Level: 10/1/2015				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	Nooksack													
02	RELOCATIONS	$59,242	$23,697	40%	$ 82,939	0.0%	$59,242	$23,697	$82,939	2022Q2	12.7%	$66,782	$26,713	$93,495
06	FISH & WILDLIFE FACILITIES	$20,482	$8,193	40%	$ 28,675	0.0%	$20,482	$8,193	$28,675	2028Q1	26.3%	$25,872	$10,349	$36,221
06	MONITORING	$405	$101	25%	$ 506	0.0%	$405	$101	$506	2032Q1	95.2%	$790	$198	$988
06	ADAPTIVE MANANGEMENT	$790	$316	40%	$ 1,106	0.0%	$790	$316	$1,106	2032Q1	36.7%	$1,080	$432	$1,512
06	ROADS, RAILROADS & BRIDGES	$6,522	$2,609	40%	$ 9,131	0.0%	$6,522	$2,609	$9,131	2028Q1	26.3%	$8,238	$3,295	$11,534
06	CHANNELS & CANALS	$624	$250	40%	$ 874	0.0%	$624	$250	$874	2028Q1	26.3%	$788	$315	$1,103
06	LEVEES & FLOODWALLS	$41,249	$16,500	40%	$ 57,749	0.0%	$41,249	$16,500	$57,749	2028Q1	26.3%	$52,104	$20,842	$72,945
18	CULTURAL RESOURCE PRESERVATION	$1,971	$788	40%	$ 2,759	0.0%	$1,971	$788	$2,759	2028Q1	26.3%	$2,490	$996	$3,486
	CONSTRUCTION ESTIMATE TOTALS:	$131,285	$52,453	40%	**183,738**		$131,285	$52,453	$183,738			$158,145	$63,139	$221,284
01	LANDS AND DAMAGES	$13,809	$2,705	20%	$ 16,514	0.0%	$13,809	$2,705	$16,514	2022Q2	12.7%	$15,566	$3,049	$18,615
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$3,282	$1,311	40%	4,593	0.0%	$3,282	$1,311	$4,593	2022Q2	27.4%	$4,181	$1,671	$5,852
1.0%	Planning & Environmental Compliance	$1,313	$525	40%	1,838	0.0%	$1,313	$525	$1,838	2022Q2	27.4%	$1,673	$668	$2,341
12.0%	Engineering & Design	$15,754	$6,294	40%	22,048	0.0%	$15,754	$6,294	$22,048	2022Q2	27.4%	$20,071	$8,019	$28,090
1.0%	Reviews, ATRs, IEPRs, VE	$1,313	$525	40%	1,838	0.0%	$1,313	$525	$1,838	2022Q2	27.4%	$1,673	$668	$2,341
0.5%	Life Cycle Updates (cost, schedule, risks)	$656	$262	40%	$918	0.0%	$656	$262	$918	2022Q2	27.4%	$836	$334	$1,170
1.0%	Contracting & Reprographics	$1,313	$525	40%	1,838	0.0%	$1,313	$525	$1,838	2022Q2	27.4%	$1,673	$668	$2,341
3.0%	Engineering During Construction	$3,939	$1,574	40%	5,513	0.0%	$3,939	$1,574	$5,513	2028Q1	62.2%	$6,391	$2,553	$8,944
2.0%	Planning During Construction	$2,626	$1,049	40%	3,675	0.0%	$2,626	$1,049	$3,675	2028Q1	62.2%	$4,261	$1,702	$5,963
1.0%	Project Operations	$1,313	$525	40%	1,838	0.0%	$1,313	$525	$1,838	2022Q2	27.4%	$1,673	$668	$2,341
31	CONSTRUCTION MANAGEMENT													
5.0%	Construction Management	$6,564	$2,623	40%	9,187	0.0%	$6,564	$2,623	$9,187	2028Q1	62.2%	$10,650	$4,255	$14,905
2.0%	Project Operation:	$2,626	$1,049	40%	3,675	0.0%	$2,626	$1,049	$3,675	2028Q1	62.2%	$4,261	$1,702	$5,963
2.5%	Project Management	$3,282	$1,311	40%	4,593	0.0%	$3,282	$1,311	$4,593	2028Q1	62.2%	$5,325	$2,127	$7,452
	CONTRACT COST TOTALS:	$189,075	$72,730		**261,805**		$189,075	$72,730	$261,805			$236,376	$91,226	**$327,602**
	OMRRR	$25,184	*$10,066*	*40%*	***$35,260***									

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Puget Sound Nearshore Ecosystem Restoration
LOCATION: Washington State
This Estimate reflects the scope and schedule in report; PSNERP Feasibility Report

DISTRICT: NWS Seattle District
POC: CHIEF, COST ENGINEERING, John Dudgeon

PREPARED: 3/15/2016

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			3/15/2016	Program Year (Budget EC):			2016					
		Effective Price Level:			10/1/2015	Effective Price Level Date:			1 OCT 15	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	North Fork													
06	FISH & WILDLIFE FACILITIES	$6,768	$2,436	36%	$9,204	0.0%	$6,768	$2,436	$9,204	2020Q2	8.4%	$7,333	$2,640	$9,973
06	MONITORING	$303	$76	25%	$379	0.0%	$303	$76	$379	2024Q1	36.8%	$415	$104	$518
06	ADAPTIVE MANANGEMENT	$1,507	$543	36%	$2,050	0.0%	$1,507	$543	$2,050	2024Q1	16.7%	$1,759	$633	$2,392
06	CHANNELS & CANALS	$1,324	$477	36%	$1,801	0.0%	$1,324	$477	$1,801	2020Q2	8.4%	$1,435	$516	$1,951
06	LEVEES & FLOODWALLS	$36,605	$13,178	36%	$49,783	0.0%	$36,605	$13,178	$49,783	2020Q2	8.4%	$39,662	$14,278	$53,941
18	CULTURAL RESOURCE PRESERVATION	$1,257	$453	36%	$1,710	0.0%	$1,257	$453	$1,710	2020Q2	8.4%	$1,362	$490	$1,852
	CONSTRUCTION ESTIMATE TOTALS:	$47,764	$17,162	36%	**$64,926**		$47,764	$17,162	$64,926			$51,965	$18,662	$70,627
01	LANDS AND DAMAGES	$11,352	$2,570	23%	$13,922	0.0%	$11,352	$2,570	$13,922	2019Q4	7.3%	$12,179	$2,757	$14,937
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$1,194	$429	36%	$1,623	0.0%	$1,194	$429	$1,623	2019Q4	15.4%	$1,378	$495	$1,873
1.0%	Planning & Environmental Compliance	$478	$172	36%	$650	0.0%	$478	$172	$650	2019Q4	15.4%	$552	$198	$750
10.0%	Engineering & Design	$4,776	$1,716	36%	$6,492	0.0%	$4,776	$1,716	$6,492	2019Q4	15.4%	$5,512	$1,981	$7,493
1.0%	Reviews, ATRs, IEPRs, VE	$478	$172	36%	$650	0.0%	$478	$172	$650	2019Q4	15.4%	$552	$198	$750
0.5%	Life Cycle Updates (cost, schedule, risks)	$239	$86	36%	$325	0.0%	$239	$86	$325	2019Q4	15.4%	$276	$99	$375
1.0%	Contracting & Reprographics	$478	$172	36%	$650	0.0%	$478	$172	$650	2019Q4	15.4%	$552	$198	$750
3.0%	Engineering During Construction	$1,433	$515	36%	$1,948	0.0%	$1,433	$515	$1,948	2020Q2	17.7%	$1,686	$606	$2,292
2.0%	Planning During Construction	$955	$343	36%	$1,298	0.0%	$955	$343	$1,298	2020Q2	17.7%	$1,124	$404	$1,528
1.0%	Project Operations	$478	$172	36%	$650	0.0%	$478	$172	$650	2019Q4	15.4%	$552	$198	$750
31	CONSTRUCTION MANAGEMENT													
5.0%	Construction Management	$2,388	$858	36%	$3,246	0.0%	$2,388	$858	$3,246	2020Q2	17.7%	$2,810	$1,010	$3,820
2.0%	Project Operation:	$955	$343	36%	$1,298	0.0%	$955	$343	$1,298	2020Q2	17.7%	$1,124	$404	$1,528
2.5%	Project Management	$1,194	$429	36%	$1,623	0.0%	$1,194	$429	$1,623	2020Q2	17.7%	$1,405	$505	$1,910
	CONTRACT COST TOTALS:	$74,162	$25,138		**$99,299**		$74,162	$25,138	$99,299			$81,666	$27,715	**$109,381**
	OMRRR	*$ 1,341.00*	*$482*	*36%*	***$1,823***									

Duckabush Causeway Replacement and Estuary Restoration
Budgetary estimate based on a FFR/EIS report- Duckabush Causeway Replacement and Estuary Restoration (#1012).

Estimated by	NWW, Cost Engineering Branch
Designed by	Seattle District
Prepared by	Anthony Rodriguez
Preparation Date	12/11/2015
Effective Date of Pricing	12/11/2015
Estimated Construction Time	480 Days

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Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Project Cost Summary			50,358,498	0	0	0	50,358,498
Duckabush	1.00	LS	50,358,498	0	0	0	50,358,498
02 Relocations	1.00	EA	32,576,792	0	0	0	32,576,792
06 Fish and Wildlife Facilities	1.00	LS	4,601,909	0	0	0	4,601,909
06 Adaptive Management	1.00	EA	1,472,640	0	0	0	1,472,640
06 Monitoring	1.00	EA	163,000	0	0	0	163,000
08 Roads, RR & Bridges	1.00	EA	6,126,858	0	0	0	6,126,858
18 Cultural Resource Preservation	1.00	LS	1,239,009	0	0	0	1,239,009
OMRRR	1.00	LS	4,178,290	0	0	0	4,178,290

Nooksack River Estuary
Nooksack River Estuary

BASIS OF COSTS: MII English Costbook and associated libraries, vendor pricing, and built crews.
SCOPE OF WORK: Final Feasibility Report
ESTIMATE CLASS; Conceptual, Level 4

Original Estimat: Jim Jetton, PE, CCE (NWW)
Revised Estimate: Anthony Rodriguez, CCC (NWS)

554

Estimated by	NWS, Cost Engineering Section
Designed by	NWS, Design Branch
Prepared by	Anthony Rodriguez, CCC
Preparation Date	3/17/2016
Effective Date of Pricing	3/17/2016
Estimated Construction Time	2,185 Days

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Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Project Cost Summary			146,636,869	0	0	0	146,636,869
Nooksack River Estuary	1.00	LS	146,636,869	0	0	0	146,636,869
02 Relocation - Construction	1.00	EA	59,242,023	0	0	0	59,242,023
06 Fish and Wildlife Facilities	1.00	LS	10,482,385	0	0	0	10,482,385
06 Adaptive Management	1.00	EA	789,631	0	0	0	789,631
06 Monitoring	1.00	EA	564,000	0	0	0	564,000
08 Roads RR & BRidges	1.00	EA	6,521,785	0	0	0	6,521,785
09 Channels and Canals	1.00	LS	623,476	0	0	0	623,476
11 Levees and Floodwalls	1.00	LS	41,248,796	0	0	0	41,248,796
18 Cultural Resource Preservation	1.00	LS	1,971,088	0	0	0	1,971,088
OMRRR	1.00	LS	25,193,685	0	0	0	25,193,685

North Fork Levee Setback
OBJECTIVE: Create tidal channels that will restore the area to a more natural condition.

BASIS OF COSTS: MII English Costbook and associated libraries, vendor pricing, and built crews.
SCOPE OF WORK: Final Feasibility Report
ESTIMATE CLASS; Conceptual, Level 4

Original Estimate: Daniel Lowry, PE, CCC (NWS)
Revised Estimate: Anthony Rodriguez. CCC (NWS)

Estimated by	NWS, Cost Engineering Section
Designed by	NWS, Design Branch
Prepared by	Anthony Rodriguez, CCC
Preparation Date	3/16/2016
Effective Date of Pricing	3/16/2016
Estimated Construction Time	551 Days

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Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	ProjectCost
Project Cost Summary			49,255,159	0	0	0	49,255,159
North Fork	1.00	LS	49,255,159	0	0	0	49,255,159
06 Fish and Wildlife Facilities	1.00	LS	6,768,044	0	0	0	6,768,044
06 Adaptive Management	1.00	LS	1,507,205	0	0	0	1,507,205
06 Monitoring	1.00	EA	451,000	0	0	0	451,000
09 Channels and Canals	1.00	LS	1,324,548	0	0	0	1,324,548
11 Levees & Floodwalls	1.00	EA	36,605,438	0	0	0	36,605,438
18 Cultural Resource Preservation	1.00	LS	1,257,015	0	0	0	1,257,015
OMRRR	1.00	EA	1,341,909	0	0	0	1,341,909

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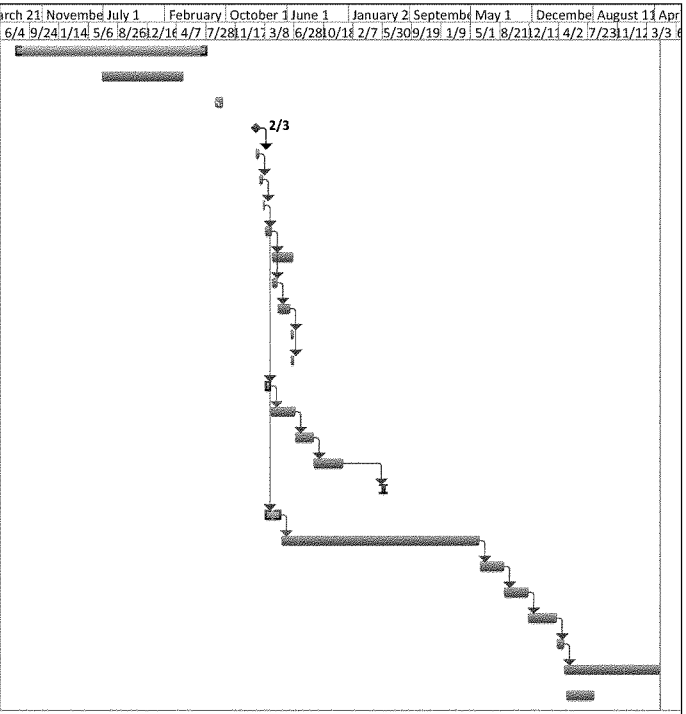
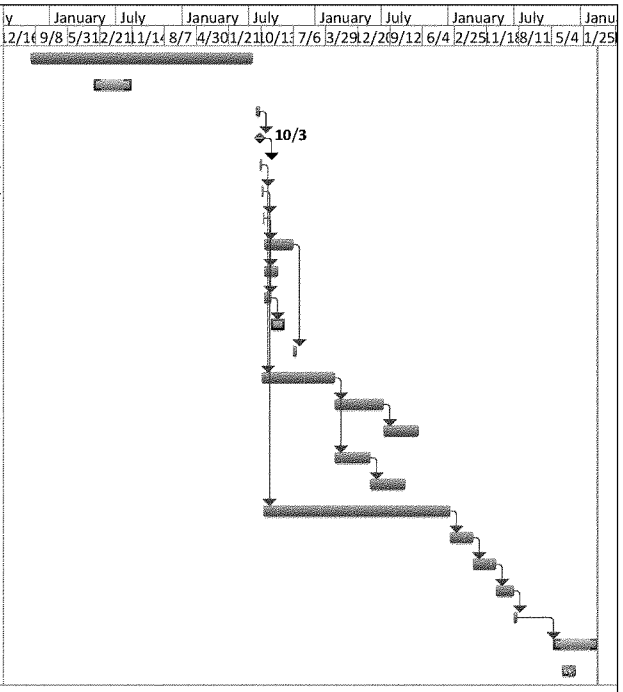
ID	Task Name	Duration	Start	Finish
1		522 days	Tue 8/1/17	Wed 7/31/19
2	PED	220 days	Wed 6/27/18	Tue 4/30/19
3	Solicitation	22 days	Sun 9/1/19	Mon 9/30/19
4	Start	0 days	Mon 2/3/20	Mon 2/3/20
5	Mobilize	10 days	Mon 2/3/20	Fri 2/14/20
6	Erosion Control	10 days	Mon 2/17/20	Fri 2/28/20
7	Clear and Grub	5 days	Mon 3/2/20	Fri 3/6/20
8	Excavation	20 days	Mon 3/9/20	Fri 4/3/20
9	Fill Placement	56 days	Mon 4/6/20	Mon 6/22/20
10	Large Channel Creation	15 days	Mon 4/6/20	Fri 4/24/20
11	Small Channel Creation	35 days	Mon 4/27/20	Fri 6/12/20
12	LWD Placement	8 days	Mon 6/15/20	Wed 6/24/20
13	Plantings	10 days	Mon 6/15/20	Fri 6/26/20
14	Temp Highway Road	17 days	Mon 3/9/20	Tue 3/31/20
15	Road Demo	66 days	Wed 4/1/20	Wed 7/1/20
16	New Pavement	50 days	Thu 7/2/20	Wed 9/9/20
17	New Utilities	80 days	Thu 9/10/20	Wed 12/30/20
18	Demo Utilties	10 days	Thu 5/27/21	Wed 6/9/21
19	Temp Construction Pad	45 days	Mon 3/9/20	Fri 5/8/20
20	High 101 Bridge Construction	540 days	Mon 5/11/20	Fri 6/3/22
21	Duckabush Road Bridge	66 days	Mon 6/6/22	Mon 9/5/22
22	Shorewood Road Bridge	66 days	Tue 9/6/22	Tue 12/6/22
23	Bridge Demo	78 days	Wed 12/7/22	Fri 3/24/23
24	Demobilize	20 days	Mon 3/27/23	Fri 4/21/23
25	Post Construction Monitoring	262 days	Mon 4/24/23	Tue 4/23/24
26	Adaptive Management	76 days	Mon 5/1/23	Mon 8/14/23



Project: Duckabush
Date: Tue 3/22/16

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

ID	Task Name	Duration	Start	Finish
1	PED	1309 days	Mon 7/29/19	Thu 8/1/24
2	Cultural Survey	220 days	Fri 1/1/21	Thu 11/4/21
3	Solicitation	22 days	Mon 9/2/24	Tue 10/1/24
4	Start	0 days	Thu 10/3/24	Thu 10/3/24
5	Mobilize	10 days	Thu 10/3/24	Wed 10/16/24
6	Erosion Control	10 days	Thu 10/17/24	Wed 10/30/24
7	Clear and Grub	5 days	Thu 10/31/24	Wed 11/6/24
8	Structure Demo	170 days	Thu 11/7/24	Wed 7/2/25
9	LWD Installation	82 days	Thu 11/7/24	Fri 2/28/25
10	Water Control Structure	42 days	Thu 11/7/24	Fri 1/3/25
11	Stormwater Pond	78 days	Mon 1/6/25	Wed 4/23/25
12	Lummi River Regrade	20 days	Thu 7/3/25	Wed 7/30/25
13	New Levees	430 days	Thu 10/17/24	Wed 6/10/26
14	New Utilities	288 days	Thu 6/11/26	Mon 7/19/27
15	Demo Utilties	205 days	Tue 7/20/27	Mon 5/1/28
16	New Pavement	210 days	Thu 6/11/26	Wed 3/31/27
17	Demo Pavement	205 days	Thu 4/1/27	Wed 1/12/28
18	Bridge Construction	1100 days	Thu 10/31/24	Wed 1/17/29
19	Bridge Demo	135 days	Thu 1/18/29	Wed 7/25/29
20	Remove Levee	135 days	Thu 7/26/29	Wed 1/30/30
21	Plantings	105 days	Thu 1/31/30	Wed 6/26/30
22	Demobilize	20 days	Thu 6/27/30	Wed 7/24/30
23	Post Construction Monitoring	262 days	Thu 5/22/31	Fri 5/21/32
24	Adaptive Management	80 days	Fri 8/1/31	Thu 11/20/31

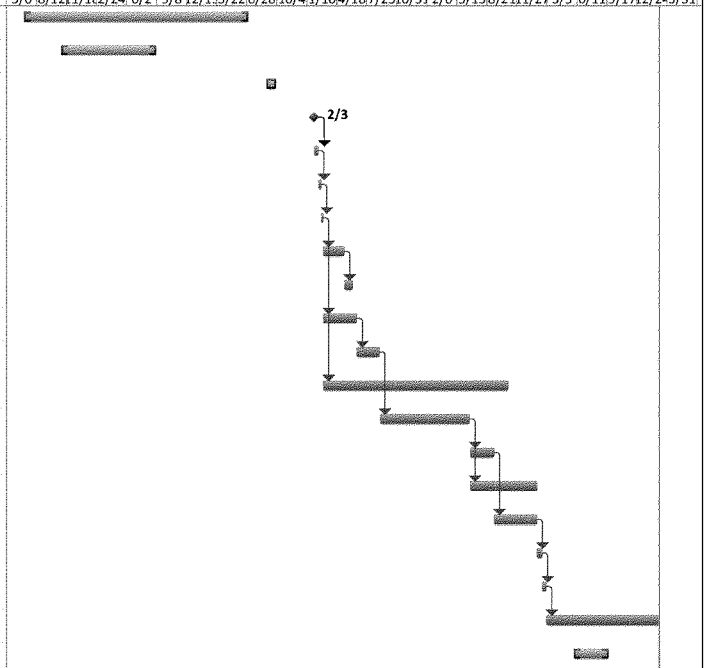


Project: Nooksack
Date: Tue 3/22/16

Task	External Milestone	Manual Summary Rollup	
Split	Inactive Task	Manual Summary	
Milestone	Inactive Milestone	Start-only	
Summary	Inactive Summary	Finish-only	
Project Summary	Manual Task	Deadline	
External Tasks	Duration-only	Progress	

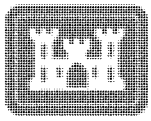
559

ID	Task Name	Duration	Start	Finish
1	PED	523 days	Sun 7/1/18	Wed 7/1/20
2	Cultural Survey	220 days	Thu 11/1/18	Wed 9/4/19
3	Solicitation	22 days	Tue 9/1/20	Wed 9/30/20
4	Start	0 days	Wed 2/3/21	Wed 2/3/21
5	Mobilize	10 days	Wed 2/3/21	Tue 2/16/21
6	Erosion Control	7 days	Wed 2/17/21	Thu 2/25/21
7	Clear and Grub	4 days	Fri 2/26/21	Wed 3/3/21
8	Building Demo	49 days	Thu 3/4/21	Tue 5/11/21
9	Demo Boat Ramp	19 days	Wed 5/12/21	Mon 6/7/21
10	Demo Paving	78 days	Thu 3/4/21	Mon 6/21/21
11	Demo Utilties	54 days	Tue 6/22/21	Fri 9/3/21
12	Traffic Control	432 days	Thu 3/4/21	Fri 10/28/22
13	New Levee	210 days	Mon 9/6/21	Fri 6/24/22
14	Channel Creation	56 days	Mon 6/27/22	Mon 9/12/22
15	Plantings	156 days	Mon 6/27/22	Mon 1/30/23
16	Remove Levee	100 days	Tue 9/13/22	Mon 1/30/23
17	Breach Dike	13 days	Tue 1/31/23	Thu 2/16/23
18	Demobilize	10 days	Fri 2/17/23	Thu 3/2/23
19	Post Construction Monitoring	263 days	Fri 3/3/23	Tue 3/5/24
20	Adaptive Management	80 days	Thu 6/1/23	Wed 9/20/23



Project: North Fork Schedule
Date: Tue 3/22/16

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress



US Army Corps
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COST AND SCHEDULE RISK ANALYSIS REPORT

FOR

Puget Sound Nearshore Ecosystem Restoration Project

Duckabush River Estuary, WA

Prepared for:

Seattle District, Seattle, WA

Prepared by:

USACE, Seattle District

Date: June 08, 2016

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Puget Sound Nearshore Environmental Restoration Project (PSNERP). In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The purpose of this project is to address and restore ecosystems through restoration of natural processes and restoration and/or re-creation of coastal wetlands and embayments. There are three sites in the recommended plan with locations throughout the Puget Sound. Restoration actions will occur near the mouth of the Duckabush River, Skagit River and Nooksack Rivers, respectively. More specifically, this CSRA report will cover in detail the Duckabush River Estuary

The proposed action to the Duckabush River Estuary would restore the natural geomorphology by removing major roadway obstructions, excavating channels, and removing fill. The action would remove two bridges that total 970 LF and associated approach road embankments along Highway 101. This will be followed by realigning Highway 101 onto a new 2100 LF bridge across the estuarine delta to restore tidal connection to the estuary. A surface street crossing (Shorewood Road) would be modified to tie into the new bridge structure. Adjacent fill at a distributary channel (Pierce Slough) would be removed. Multiple tidally influenced distributary river channels summing to 1,155 LF would be reestablished, and blind tidal channels summing to 4,200 LF would be excavated within the marsh areas.

Specific to the Duckabush River Estuary, the current base cost estimate approximates $62M, including planning, engineering, design & construction management costs, but excluding contingency and escalation. The CSRA is calculated on the estimated remaining construction base cost of $46M expressed in FY2016 dollars. The CSRA base cost excluded lands, damages and PL 91-646 relocation costs of $491K, escalation and contingencies. Since the Real Estate office provided a separate 13% contingency for its real estate and PL 91-646 relocations requirements, Cost Engineering performed the CSRA on the estimated remaining construction costs. Based on the results of the risk analysis, Cost Engineering recommends a contingency value of $21M on the remaining construction work or approximately 46% of base project cost. The same 46% was then applied to engineering and design and construction management.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based on cost and percent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	**$46,200,000**	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$64,200,000	39%
80%	**$67,400,000**	**46%**
90%	$69,200,000	49%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on three separate occasions: June 2012, July 2014 and again in December 2015. That period of time allowed improved project scope definition, investigations, design and cost information, and resulted in revised risks in certain project areas. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $17.8M and schedule risks adding another potential of $3.4M, both at an 80% confidence level.

A key risk, the Bridge Foundation remains uncertain due to a limited design and a lack of soil analysis. Concern has been mitigated by increasing the foundation at the bridge abutments. The current design includes two pile caps, four piers and four caissons at each abutment to mitigate any potential soil liquefaction. The PDT believe this approach is conservative. However it is very likely that the design of the bridge abutments will change as the project moves further in design.

Another key risk, the bridge cost model, remains uncertain. Since the design of the bridge is limited in scope and detail there is potential for the bridge design to change at the next phase of design. Additionally, many assumptions were made in order to estimate a cost for this feature of work. To mitigate this risk the PDT assumed a cost increase of 30% on the bridge cost model.

The last key risk regarding project funding, remains uncertain. This project will be competing with other projects on a national level for both funding and personnel resources. Factor in the large project cost and it is very likely that this project will be funded on a yearly basis and not one large lump sum. There is the risk that any delay in funding could impact the project resourcing and sequencing. Reducing funding leads to breaking down work packages to be executed in smaller outlay increments.

Cost Risks: From the CSRA, the key or greater Cost Risk items in terms of cost variability potential include:

- TL-5: Bridge & Foundation Placement – Several elements of the bridge scope are likely to change including bridge & foundation geometry.
- EST-3: Bridge Cost Model – The cost book items and construction assumptions may not be entirely accurate or applicable to the project. It is likely that there will be changes to the bridge cost model as the design progresses.

Moderate risks, when combined, can also become a cost impact.

- CA-1: Small Business Markups – The cost estimate assumes that all work will be done by a small business contractor. However, if the contract solicitation was restricted further such as 8A, HUBZONE, SDVOSB or Woman-Owned the expected home office overhead markup rate would likely be higher than what is already assumed in the cost estimate.
- TL-1: Earthwork Design Requirements – Project is in preliminary planning stages and no grading details are known. There is limited knowledge about what road embankment prisms will eventually be required.
- CON-1: Post-Award Contract Modifications – At this early state of design there is the likely risk that unsuitable soil conditions could be encountered once construction has commenced. This most certainly would result in a modification to the contract and could have impacts on cost as well as schedule.
- CON-3 Production Rate and Schedule – The cost estimate assumes that construction will take place in fair weather conditions. Conservative production rates were used throughout the cost estimate however it is impossible to predict the crew sizes the contractor will have on site or the actual production rates given the site constraints.

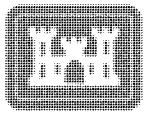
Schedule Risks: The schedule risk indicates some uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- PPM-5: Project Funding – Federal and non-Federal parties competing with other projects/programs for both funding and staff resources.

Moderate risks, when combined, can also become a time and resulting cost impact.

- EST-3: Bridge Cost Model (Estimate Risk Aggregate) – The assumed crew sizes and production rates to construct the bridge may be low, resulting in a longer construction duration.
- PR-3: Project Opposition – A pending lawsuit or failure to acquire land has the potential to stop the project and will require a project reevaluation.
- PPM-1: Project Scheduling – High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.
- LD-1: Unknown Utilities: - Actual utility removal, decommissioning or relocation quantities will be determined during PED.
- RE-1: Cultural Resources – If cultural artifacts are uncovered during construction this will stop construction in the identified area.

Recommendations: Timely coordination and risk resolution between the Sponsor and USACE is needed in areas of project funding, bridge design and assumptions, earthwork design and production rates and schedules. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of the remaining project work within an approved budget and appropriation.



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COST AND SCHEDULE RISK ANALYSIS REPORT

FOR

Puget Sound Nearshore Ecosystem Restoration Project

Nooksack River Delta, WA

Prepared for:

Seattle District, Seattle, WA

Prepared by:

USACE, Seattle District

Date: June 08, 2016

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Puget Sound Nearshore Environmental Restoration Project (PSNERP). In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The purpose of this project is to address and restore ecosystems through restoration of natural processes and restoration and/or re-creation of coastal wetlands and embayments. There are three sites in the recommended plan with locations throughout the Puget Sound. Restoration actions will occur near the mouth of the Duckabush River, Skagit River and Nooksack Rivers, respectively. More specifically, this CSRA report will cover in detail the Nooksack River Delta

The proposed action to the Nooksack River Delta would restore riverine and tidal flow as well as sediment transport and delivery processes throughout a substantial portion of the historical Nooksack River delta. This will be accomplished by a combination of construction features that would modify levees, roads, and other hydrological barriers. Construction of approximately 47,000 LF of new setback levees would provide flood risk management protection for active businesses, residences, farms, transportation infrastructure, and Lummi Nation lands in the project area. Features of work associated with levee setback construction include but are not limited to: 12,280 LF of levee removal, installation of 3 log jam structures, installation of 1 new water control structure and 9,980 LF of channel and berm regarding. Construction on existing infrastructure includes but is not limited to: removal of 6 bridges and approach road section and construction of 6 new bridges and approach road sections.

Specific to the Nooksack River Delta, the current base cost estimate approximates $189M, including planning, engineering, design & construction management costs, but excluding contingency and escalation. The CSRA is calculated on the estimated remaining construction base cost of $131M expressed in FY2016 dollars. The CSRA base cost excluded lands, damages and PL 91-646 relocation costs of $13.8M. Since the Real Estate office provided a separate 20% contingency for its real estate and PL 91-646 relocations requirements, Cost Engineering performed the CSRA on the estimated remaining construction costs. Based on the results of the risk analysis, Cost Engineering recommends a contingency value of $52M on the remaining construction work or approximately 40% of base project cost. The same 40% was then applied to engineering and design and construction management.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based on cost and percent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	$131,300,000	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$161,700,000	33%
80%	**$169,400,000**	**40%**
90%	$174,200,000	44%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on three separate occasions: June 2012, July 2014 and again in December 2015. That period of time allowed improved project scope definition, investigations, design and cost information, and resulted in revised risks in certain project areas. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $43.5M and schedule risks adding another potential of $4.7M, both at an 80% confidence level.

A key risk, the bridge cost model, remains uncertain. Since the design of the bridge is limited in scope and detail there is potential for the bridge design to change at the next phase of design. Additionally, many assumptions were made in order to estimate a cost for this feature of work. To mitigate this risk the PDT assumed a cost increase of 30% on the bridge cost model.

Another key risk, bid competition, remains uncertain as well. This project is assumed to be solicited under one large contract. The number of prime contractors who can meet the bonding requirements will be limited. In addition, the current construction market in the Seattle area is very active. As a result of the market being saturated with work, contractors will not be as aggressive when trying to acquire new work. This risk will be reevaluated to as the project gets closer to solicitation.

Cost Risks: From the CSRA, the key or greater Cost Risk items in terms of cost variability potential include:

- CA-3: Bid Competition – If the market is saturated with work, contractors will place higher margins on the work they bid.
- EST-3: Bridge Cost Model – The cost book items and construction assumptions may not be entirely accurate or applicable to the project. It is likely that there will be changes to the bridge cost model as the design progresses.

Moderate risks, when combined, can also become a cost impact.

- CA-1: Small Business Markups – The cost estimate assumes that all work will be done by a small business contractor. However, if the contract solicitation was restricted further such as 8A, HUBZONE, SDVOSB or Woman-Owned the expected home office overhead markup rate would likely be higher than what is already assumed in the cost estimate.
- TL-1: Earthwork Design Requirements – Project is in preliminary planning stages and no grading details are known. There is limited knowledge about what road embankment prisms will eventually be required.
- TL-5: Bridge & Foundation Placement – Several elements of the bridge scope are likely to change including bridge & foundation geometry.
- CON-1: Post-Award Contract Modifications – At this early state of design there is the likely risk that unsuitable soil conditions could be encountered once construction has commenced. This most certainly would result in a modification to the contract and could have impacts on cost as well as schedule.
- CON-3 Production Rate and Schedule – The cost estimate assumes that construction will take place in fair weather conditions. Conservative production rates were used throughout the cost estimate however it is impossible to predict the crew sizes the contractor will have on site or the actual production rates given the site constraints.

Schedule Risks: The schedule risk indicates some uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

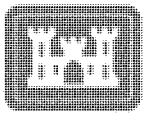
- EST-1, 3 & 4: Estimate Risk Aggregate – The estimate risk aggregate corresponds to schedule risk impact as a result of inaccurate assumptions made in the cost estimate on risks such as: changes in soil conditions, bridge cost model or flooding and work windows. The likelihood of these risk impacts happening sequentially is very slim. Most likely if two or more estimate risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should all three risks occur during the project duration. Of the three estimate risks the schedule impact from the bridge cost model is the greatest.

There is high uncertainty in the crew sizes and production rates used by the contractor.

Moderate risks, when combined, can also become a time and resulting cost impact.

- TL-2, 5, 7, 8 & 9: Technical Risk Aggregate – The technical risk aggregate corresponds to schedule risk impact as a result of uncertainty on risks such as: hydraulic structures, bridge & foundation placement, levee/road settlement, borrow source and storm water ponds. The likelihood of these risk impacts happening sequentially is very slim. Most likely if two or more technical risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should all five risks occur during the project duration. Of the five technical risks the schedule impact from the bridge & foundation placement is the greatest. The design of the bridge foundations is very likely to change as the design progresses.
- LD-1: Unknown Utilities: - Actual utility removal, decommissioning or relocation quantities will be determined during PED.
- LD-2: Bridge/Structure Removal – There are 34 structures to be removed and additional structures could be present. The information on these structures is limited and the scope could increase as the design progresses.
- CON-1 & 2: Construction Risk Aggregate – The construction risk aggregate corresponds to schedule risk impact as a result of uncertainty on risks such as: post-award contract modifications and production rate and schedule. The likelihood of these risk impacts happening sequentially is very slim. Most likely if both construction risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should all both risks occur during the project duration. Of the two technical risks the schedule impact from the post-award contract modifications is the greatest.
- PR-3: Project Opposition – A pending lawsuit or failure to acquire land has the potential to stop the project and will require a project reevaluation.

Recommendations: Timely coordination and risk resolution between the Sponsor and USACE is needed in areas of project funding, bridge design and assumptions, earthwork design and production rates and schedules. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of the remaining project work within an approved budget and appropriation.



US Army Corps
of Engineers®

COST AND SCHEDULE RISK ANALYSIS REPORT

FOR

Puget Sound Nearshore Ecosystem Restoration Project

North Fork Skagit River Delta, WA

Prepared for:

Seattle District, Seattle, WA

Prepared by:

USACE, Seattle District

Date: June 08, 2016

EXECUTIVE SUMMARY

The US Army Corps of Engineers (USACE), District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Puget Sound Nearshore Environmental Restoration Project (PSNERP). In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a *Monte-Carlo* based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommended 80% confidence level of successful execution to project completion.

The purpose of this project is to address and restore ecosystems through restoration of natural processes and restoration and/or re-creation of coastal wetlands and embayments. There are three sites in the recommended plan with locations throughout the Puget Sound. Restoration actions will occur near the mouth of the Duckabush River, Skagit River and Nooksack Rivers, respectively. More specifically, this CSRA report will cover in detail the North Fork Skagit River Delta

The proposed action to the North Fork Skagit River Delta would restore the riverine floodplain and tidal connectivity along the lower reach of the North Fork of the Skagit River. This will require constructing a new 12,300 LF flood risk management levee further inland. The 15,700 LF existing levee would be lowered and selectively breached in 4 locations to allow inundation of the estuarine emergent marsh and sustain back channel habitat. Forested floodplain habitat would be created along the lowered levee adjacent to the mainstem river channel. This will be done by excavating and creating 39,200 LF of tidal channels, removing 17 buildings in the flood plain, removing 344,300 SF of existing road and plant riparian vegetation over approximately 50 acres.

Specific to the North Fork Skagit River Delta, the current base cost estimate approximates $74M, including planning, engineering, design & construction management costs, but excluding contingency and escalation. The CSRA is calculated on the estimated remaining construction base cost of $48M expressed in FY2016 dollars. The CSRA base cost excluded lands, damages and PL 91-646 relocation costs of $11.4M. Since the Real Estate office provided a separate 23% contingency for its real estate and PL 91-646 relocations requirements, Cost Engineering performed the CSRA on the estimated remaining construction costs. Based on the results of the risk analysis, Cost Engineering recommends a contingency value of $17M on the remaining construction work or approximately 36% of base project cost. The same 36% was then applied to engineering and design and construction management.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based on cost and

percent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-1. Construction Contingency Results

Base Case Construction Cost Estimate	$47,800,000	
Confidence Level	**Construction Value ($$) w/ Contingencies**	**Contingency (%)**
50%	$62,400,000	30%
80%	**$65,000,000**	**36%**
90%	$66,600,000	39%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The PDT worked through the risk register on three separate occasions: June 2012, July 2014 and again in November 2015. That period of time allowed improved project scope definition, investigations, design and cost information, and resulted in revised risks in certain project areas. The key risk drivers identified through sensitivity analysis suggest a cost contingency of $13.3M and schedule risks adding another potential of $3.9M, both at an 80% confidence level.

A key risk, bid competition, remains uncertain. This project is assumed to be solicited under one large contract. The number of prime contractors who can meet the bonding requirements will be limited. In addition, the current construction market in the Seattle area is very active. As a result of the market being saturated with work, contractors will not be as aggressive when trying to acquire new work. This risk will be reevaluated to as the project gets closer to solicitation.

The last key risk regarding project funding, remains uncertain. This project will be competing with other projects on a national level for both funding and personnel resources. Factor in the large project cost and it is very likely that this project will be funded on a yearly basis and not one large lump sum. There is the risk that any delay in funding could impact the project resourcing and sequencing. Reducing funding leads to breaking down work packages to be executed in smaller outlay increments.

Cost Risks: From the CSRA, the key or greater Cost Risk items in terms of cost variability potential include:

- CA-1: Small Business Markups – The cost estimate assumes that all work will be done by a small business contractor. However, if the contract solicitation was restricted further such as 8A, HUBZONE, SDVOSB or Woman-Owned the expected home office overhead markup rate would likely be higher than what is already assumed in the cost estimate.
- CA-3: Bid Competition – If the market is saturated with work, contractors will place higher margins on the work they bid.

Moderate risks, when combined, can also become a cost impact.

- TL-5: Levee/Road Settlement – The current design allows 1 foot of settlement. This amount will be re-examined in PED. If settlement occurs in excess of the amount anticipated, then additional materials would very likely be required.
- TL-6: Borrow Site – The MII estimate assumes that offsite disposal and borrow sites are available within 30 miles. However, it is likely that multiple sources will be needed, and, consequently, the haul distance may increase.
- LD-1: Unknown Utilities: - Actual utility removal, decommissioning or relocation quantities will be determined during PED.
- CON-1: Post-Award Contract Modifications – At this early state of design there is the likely risk that unsuitable soil conditions could be encountered once construction has commenced. This most certainly would result in a modification to the contract and could have impacts on cost as well as schedule.
- EST-2 Large Woody Debris & Plantings – The scope is very limited and quantities are broad. The 2012 design quantities for large woody debris and plantings were reviewed and updated. The current design quantities are expected to change again when this project enters PED.

Schedule Risks: The schedule risk indicates some uncertainty of key risk items, time duration growth that can translate into added costs. Over time, risks increase on those out-year contracts where there is greater potential for change in new scope requirements, uncertain market conditions, and unexpected high inflation. The greatest risk is:

- PPM-5: Project Funding – Federal and non-Federal parties competing with other projects/programs for both funding and staff resources.

Moderate risks, when combined, can also become a time and resulting cost impact.

- PPM-1: Project Scheduling – High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.

- TL-2, 4, 5, 6 & 7: Technical Risk Aggregate – The technical risk aggregate corresponds to schedule risk impact as a result of uncertainty on risks such as: hydraulic structures, sea level change, additional armoring, levee/road settlement, borrow site and storm water ponds. The likelihood of these risk impacts happening sequentially is very slim. Most likely if two or more technical risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should all five risks occur during the project duration. Of the five technical risks the schedule impact from additional armoring and storm water ponds is the greatest. The scope and magnitude for both risks is likely to change with the potential of additional armoring and additional storm water ponds.
- CON-1 & 2: Construction Risk Aggregate – The construction risk aggregate corresponds to schedule risk impact as a result of uncertainty on risks such as: post-award contract modifications and care and diversion of water. The likelihood of these risk impacts happening sequentially is very slim. Most likely if both construction risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should all both risks occur during the project duration. Of the two technical risks the schedule impact from the post-award contract modifications is the greatest.
- EST-1, & 3: Estimate Risk Aggregate – The estimate risk aggregate corresponds to schedule risk impact as a result of inaccurate assumptions made in the cost estimate on risks such as: changes in soil conditions and flooding and work windows. The likelihood of these risk impacts happening sequentially is very slim. Most likely if both estimate risks did occur there will be some concurrent work overlap, which is why a reasonable aggregate duration was used to capture the "most likely" worst case schedule impact should both risks occur during the project duration. Of the two estimate risks the schedule impact flooding and work windows is the greatest because this risk has the potential to stop construction.

Recommendations: Timely coordination and risk resolution between the Sponsor and USACE is needed in areas of project funding, bridge design and assumptions, earthwork design and production rates and schedules. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of the remaining project work within an approved budget and appropriation.

Attachment B – Applied Geomorphology Guidelines and Hierarchy of Openings

Puget Sound Nearshore Ecosystem Restoration Project

Strategic Restoration Conceptual Engineering – Design Report

Applied Geomorphology Guidelines and Hierarchy of Openings

March 2011

Applied Geomorphology Guidelines – Revised Draft Phase 2 Document PSNERP Conceptual Design

December 20 2010

These Applied Geomorphology Guidelines will be used by the ESA team's conceptual designs. The Guidelines will be used as needed in the designs and to aid in quality control review. These guidelines may be revised to account for lessons learned during Phase 2 and for subsequent use.

The guidelines are intended only for conceptual design by the PSNERP team. These guidelines are established partly to provide a means of developing uniform designs, for quality control and precision, but also to facilitating future refinements. Further research and data collection are required to develop guidelines for broader application.

These guidelines use empirical models calibrated with data collected from field sites. Therefore, these guidelines are most useful when the site parameters lie within the range of the calibration data. Parameters include tide range, sediment and vegetation, fluvial effects, salinity (which affects plant types and geomorphology), and in some cases wave and littoral climate. Comprehensive data sets are not presently available for Puget Sound. The guidelines are based on both local data sets and data sets from other locations, with some adjustments, primarily for tide range. Therefore, the accuracy of the regressions provided here can be considered approximate. Historic data from the site (e.g. channel width from a T-Sheet) or nearby reference data (e.g. Hood's data for the Skagit, Barnard's data for Discovery Bay marshes) may be used instead of these guidelines.

The Guidelines are organized as follows:

1. Tides: Tide design parameters are identified for NOS tide stations selected to represent the varying tides in Puget Sound. Tide ranges are tabulated. Tidal datum conversion from Mean Lower Low Water (MLLW) to North American Vertical Datum (NAVD88) are provided at each tide station.

2. Tidal Marsh Channels: Regression lines and graphs are provided to relate channel geometry (channel cross-sectional area, width and depth) to marsh area and tidal prism. A set of regressions and graphs are provided for each tide station identified in (1), based on the tide range. A procedure is provided to estimate channel geometry with combined tidal and stream discharge.

3. Tidally-Influenced Fluvial Channels: Guidance for tidally influenced fluvial channels is to use historic data, remnant channel geometry and available published data on a site-specific basis.

4. Tidal Inlets: A set of graphs are provided for tidal inlets where wave action and littoral drift affect the channel geometry and, in particular, limit the tide range. The graphs allow prediction of the tidal prism necessary for an open inlet and the size of the inlet cross section for a given tidal prism.

5. Beach Geometry: Guidance is provided to estimate the berm elevation of coarse sediment beaches.

1. Tides:

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) has defined sub basins of Puget Sound (Figure 1). Tide stations have been selected to characterize the tidal regime for each sub basin. Since the tides vary along each arm of Puget Sound (for example, the tide is amplified with distance south through Hood Canal), several tide stations are indentified for each sub basin, as shown in Figure 1. Table 1 lists the tide stations and their tidal datums published by the National Ocean Service (NOS). A conversion between tidal datums and the project vertical datum (NAVD88) are provided. The conversions are those published by the NOS or are based on a review of the tidal benchmarks and provided by Pacific Surveying and Engineering (PSE) and ESA PWA as part of this project. The sources of the conversion and level of confidence are provided.

Each action should define the tidal datums and NAVD conversion used and the sources.

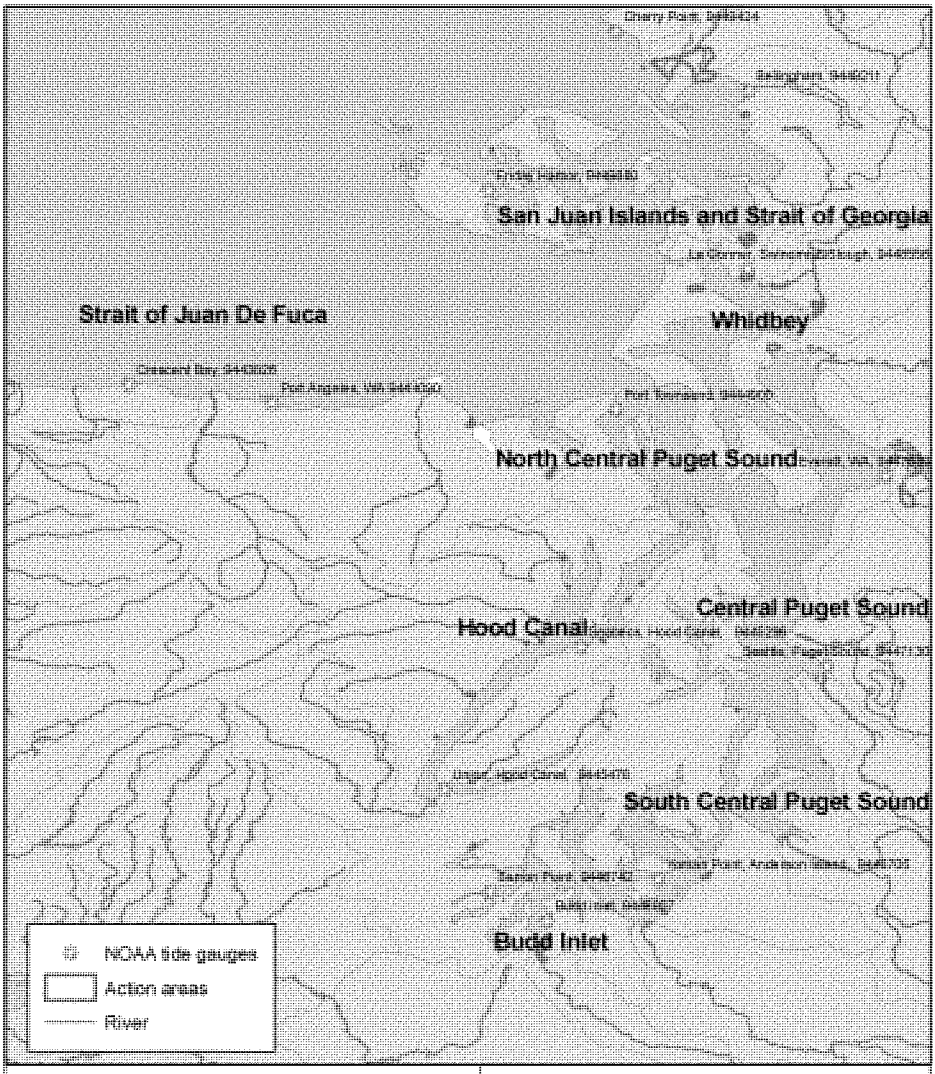

San Juan Islands and Strait of Georgia
Strait of Juan De Fuca
Whidbey
North Central Puget Sound
Central Puget Sound
Hood Canal
South Central Puget Sound
Budd Inlet
NOAA tide gauges
Action areas
River
Source: NOAA
Note: Subregion names are bold with NOAA tide gauge reference number.
N
0
10
20
40
Miles
Figure X
PSNERP
NOAA Tide Gauge Locations
PWA
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Table 1: Tides Stations, tidal datums and NAVD conversions.

2036.01 Puget Sound
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11/22/2010
Modfied B.Battalio, 12/9/2010
Puget Sound Tide Gages

				ft MLLW							ft NAVD							
Station	NOS #	Start of Record	End of Record	MLLW	MLW	MSL	MTL	MHW	MHHW	MLLW to NAVD Conversion (ft)	MLLW	MLW	MSL	MTL	MHW	MHHW	Source of Datum Conversion	Conversion Level of Confidence*
Cherry Point	9449424	Nov-71	present	0.00	2.61	5.28	5.47	8.32	9.15	-0.96	-0.96	1.65	4.32	4.51	7.36	8.19	PSE Verrified	2
Bellingham	9449211	Mar-73	Jul-75	0.00	2.35	4.95	5.07	7.79	8.51	-0.48	-0.48	1.87	4.47	4.59	7.31	8.03	NOS Tidal Datums	4
Friday Harbor	9449880	Jan-32	present	0.00	2.29	4.55	4.70	7.11	7.76	-0.53	-0.53	1.76	4.02	4.17	6.58	7.23	PSE, WSDOT data	3
La Conner, Swinomish Slough	9448558	Jun-35	Feb-73	0.00	2.70	5.96	5.18	9.43	10.35	-1.51	-1.51	1.19	4.45	3.67	7.92	8.84	PSE Verrified	4
Crescent Bay	9443826	Sep-78	Nov-78	0.00	2.16	4.22	4.32	6.47	7.06	-0.42	-0.42	1.74	3.80	3.90	6.05	6.64	PSE Verrified	4
Port Angeles, WA	9444090	Aug-75	present	0.00	1.93	4.25	4.23	6.52	7.07	-0.43	-0.43	1.50	3.82	3.80	6.09	6.64	NOS Tidal Datums	4
Port Townsend	9444900	Dec-71	present	0.00	2.50	4.99	5.17	7.84	8.52	-1.11	-1.11	1.39	3.88	4.06	6.73	7.41	PSE Verrified	3
Everett, WA	9447659	Dec-76	Feb-96	0.00	2.80	6.48	6.51	10.21	11.09	-2.30	-2.30	0.50	4.18	4.21	7.91	8.79	NOS Tidal Datums	4
Seabeck, Hood Canal	9445296	Mar-35	Mar-78	0.00	2.99	6.75	6.76	10.54	11.49	-2.62	-2.62	0.37	4.13	4.14	7.92	8.87	PSE, VDATUM ONLY!!	1
Seattle, Puget Sound	9447130	Jan - 1899	Sep-88	0.00	2.83	6.64	6.66	10.49	11.36	-2.34	-2.34	0.49	4.30	4.32	8.15	9.02	NOS Tidal Datums	4
Union, Hood Canal	9445478	Mar-78	Mar-78	0.00	3.01	6.96	6.94	10.87	11.85	-2.84	-2.84	0.17	4.12	4.10	8.03	9.01	NOS Tidal Datums	4
Yoman Point, Anderson Island	9446705	Feb-78	Nov-96	0.00	2.94	7.71	7.75	12.55	13.48	-3.78	-3.78	-0.84	3.93	3.97	8.77	9.70	PSE, VDATUM ONLY!!	1
Barron Point	9446742	Sep-88	Mar-89	0.00	3.02	8.29	8.28	13.55	11.52	-4.08	-4.08	-1.06	4.21	4.20	9.47	7.44	PSE, VDATUM ONLY!!	1
Budd Inlet	9446807	Apr-96	Dec-96	0.00	3.07	8.31	8.30	13.53	14.48	-4.05	-4.05	-0.98	4.26	4.25	9.48	10.43	PSE, VDATUM ONLY!!	1

* Level of Confidence: 4 highest, 1 lowest.

"\\Mars\Projects\2036.01_PSNERP_Phase_1_Conceptual_Engineering\Applied Geomorphology Guidelines\NAVD MLLW Conversions\PSE Survey PSNERP_DATUM_CONVERSIONS 113010.pdf"

2. Tidal Salt Marsh Channels (Channel Modification, Dike Removal, Hydraulic Connection)

Tidal marsh channels are often sized based on applied geomorphology, typically using hydraulic geometry or allometry (Williams et al, 2002; Hood, 2002). Unfortunately, existing data sets are not adequate to develop guidelines for Puget Sound, and research indicates large variation between systems and locations (Hood, 2007; 2002). Still, some basis is needed to size channels in the conceptual designs as these are key drivers of quantity and cost estimates. Therefore, the guidelines presented here can be considered more of an engineering method and not vetted from a scientific perspective.

Hydraulic geometry has been used primarily in the study of fluvial and tidal systems, where channel parameters such as stream width or depth are regressed with area of the watershed (used as a surrogate for tidal prism and discharge). The form of the equation is typically a power function:

$$Y = a*x^n,$$

Where x is a independent variable (eg marsh area or watershed area),Y is the dependent variable (tidal channel width or stream depth), a and n are empirically derived coefficients determined from a regression of the log-transformed independent and dependent variables.

The hydraulic geometry of tidal channel parameters has been investigated in Washington at the Chehalis estuary by Hood (2002) and at the Skagit delta by Hood (2007). In the Chehalis work, log-transformed slough outlet width and outlet depth are shown to scale tightly (r^2 >0.95 for both) with outlet length for the Chehalis river sloughs. However, when three other nearby systems are analyzed in a similar fashion, there are significant differences (95% confidence level) in the regression estimates for nearly all of the systems analyzed. Hood (2002) indicates that these differences are likely a result of watershed processes, such as run off or soils, and that these differences must be integrated into the development of a restoration project. Furthermore, two of the systems investigated (Willapa River and South Fork Willapa River sloughs) undergo the same tidal regime, but have somewhat differing hydraulic geometry scaling relations.

Similar scaling regressions were performed in the Skagit delta, but in this work, outlet channel depth was not included in the analyses (Hood, 2007). As above, there are significant differences in the scaling relationships between channel outlet width and marsh island area for similar, nearby locations. In the Skagit delta area, these differences are likely driven by sedimentation and discharge from the Skagit river (Hood, 2007).

Approximate Hydraulic Geometry for Puget Sound, Extrapolating San Francisco Bay Regressions

The most expeditious means of developing guidelines for sizing tidal marsh channels is to modify the guidelines for San Francisco Bay (Williams et al, 2002; PWA, 1995). San Francisco Bay data sets are large

and have been used successfully in design of marshes from a few acres to thousands of acres. While Puget Sound marshes should have different geometry due to different sediments, salinities and plants and greater rainfall effects, the primary difference is believed to be driven by the larger tide ranges.

These regressions are intended to represent future equilibrium conditions. In most cases, these dimensions are recommended for construction, with modification for constructability and slope stability if important. Overall, channels can be expected to evolve along with the marsh and take decades to reach an equilibrium condition, largely depending on sediment supply and vegetation establishment.

To account for the larger tide range in the Puget Sound area (diurnal range 7' to 16' with an average of about 10.5'), we adjusted the regression lines for San Francisco Bay data. First, we compared the large San Francisco bay data set (typical diurnal tide range about 5.8ft) with the subset from southern San Francisco Bay where the tides are much larger (range about 8.8ft). We then calculated the change in regression lines between the two data sets, and related the differences to percent increase in tide range. We then prorated this increase based on the tide ranges in Puget Sound.

Figures 2, 3 and 4 show data from San Francisco Bay (Williams et al, 2002) and Discovery Bay (Barnard, project worksheets, 2010), and regression lines by Hood (2002) and PWA (2003). The recommended regressions are those in red. These are example regressions for one tide station.

The above methodology was applied to 14 tide ranges defined at tide gauges distributed throughout the study area. This resulted in adjusted regression lines for each of the tide stations that are listed in section 1. Fourteen graphs (one for each tide station) are provided in the Appendix. Each graph includes three lines:

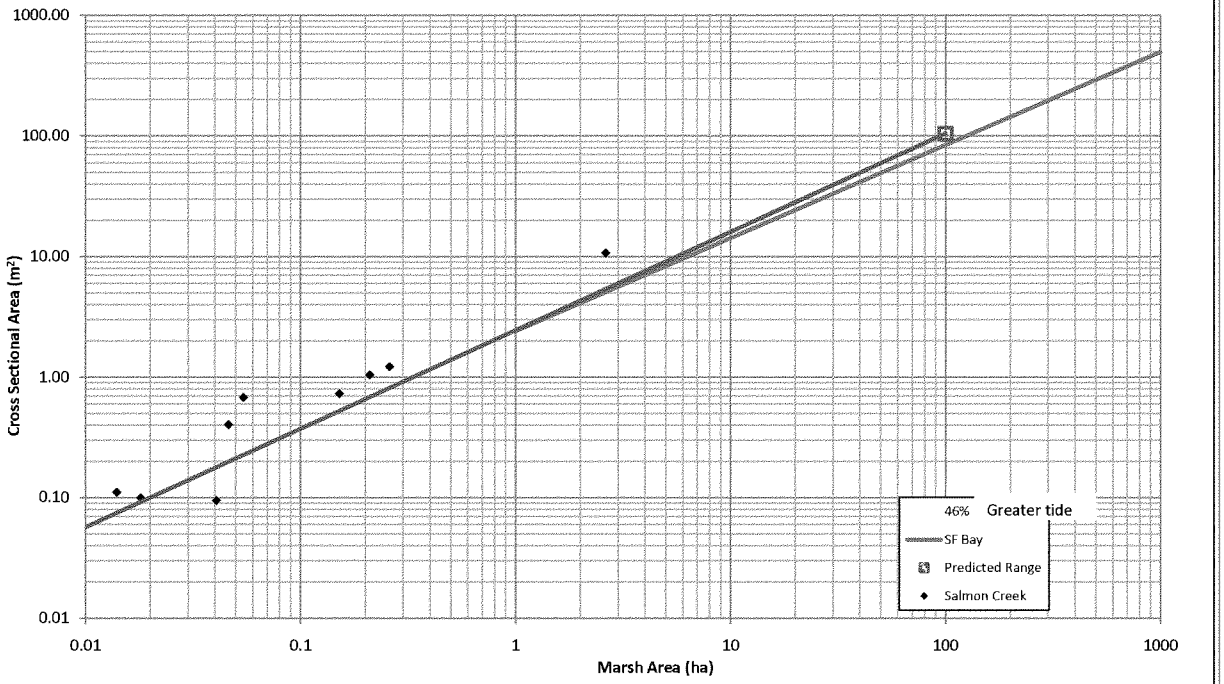
- Channel Cross section area (feet squared) vs. Marsh Area (acres);
- Channel Width (feet) vs. Marsh Area (acres); and,
- Channel Depth (feet) vs. Marsh Area (acres).

Upsizing to include stream discharge effects and additional tidal prism

The above discussion is based on tidal prism being the primary channel forming parameter, and uses marsh area as surrogate for tidal prism. Many Puget Sound marshes have significant freshwater inputs which add to the scouring power during ebb tides and therefore can be expected to increase the size of larger channels. To calculate the hydraulic geometry of a channel that incorporates fluvial discharge, the following methods are proposed. First, calculate the volume of water associated with fluvial discharge over the ebb period. Second, calculate the channel cross-sectional area from the marsh area. Third, using the Williams et al (2002) graph of tidal prism versus cross-sectional area:

a) locate the initial estimated cross-sectional area,

b) estimate the associated tidal prism,



Notes: Predicted width regressions are pro-rated based upon the depth and marsh area hydraulic geometry regressions of South SF bay and SF bay and tide range at given location. % greater tide refers to % greater than SF bay tides and is used to determine predicted range.
Source: Regression equations modified from Williams et al. (2002).

figure 2
PSNERP

Channel area hydraulic geometry

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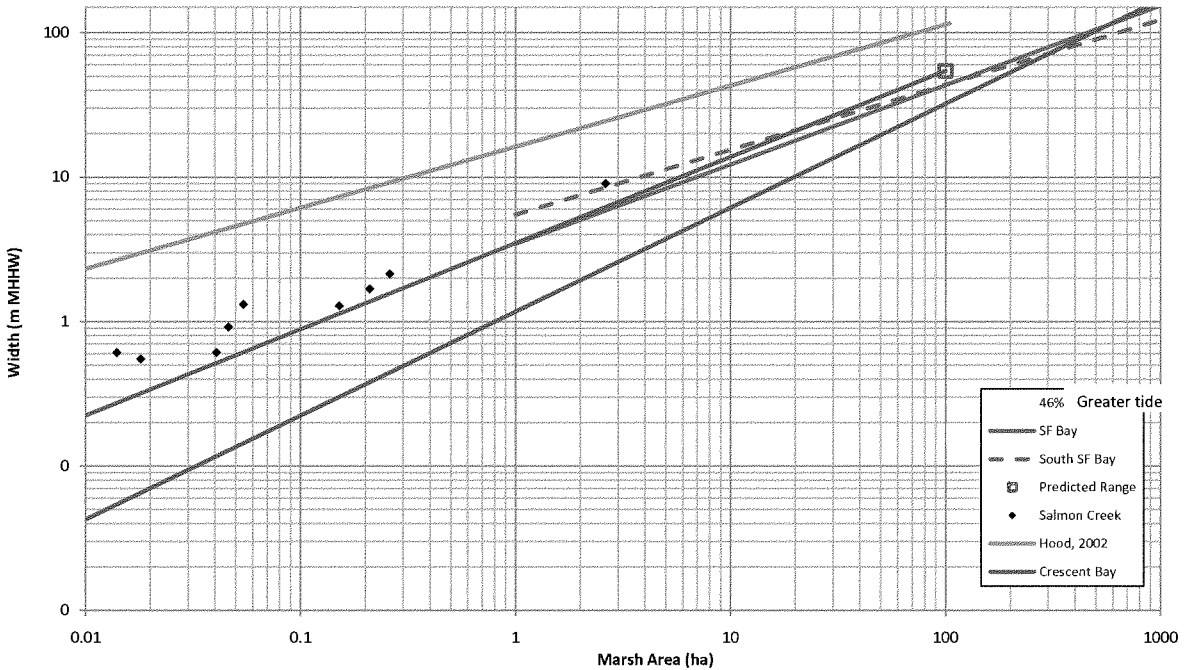

Notes: Predicted width regressions are pro-rated based upon the depth and marsh area hydraulic geometry regressions of South SF bay and SF bay and tide range at predicted location.**% greater tide refers to % greater than SF bay tides and is used to determine predicted range.**
Source: Regression equations modified from Williams et al. (2002).

figure 3
PSNERP

Channel Width hydraulic geometry

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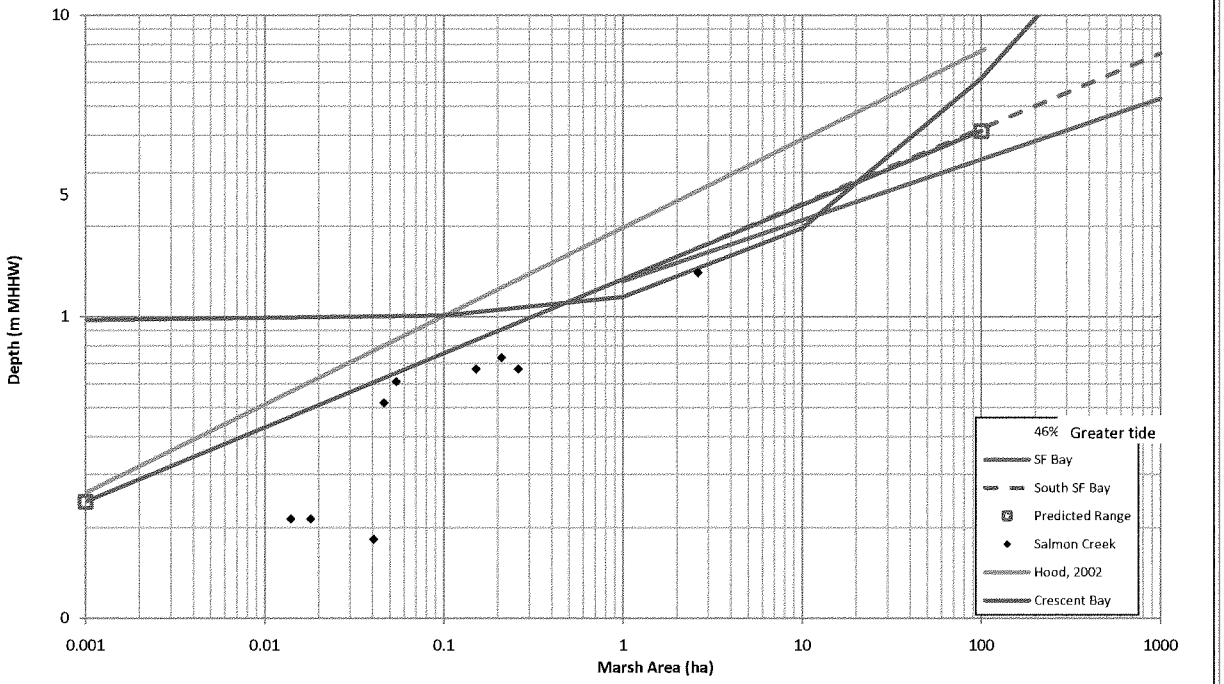

Notes: % greater tide refers to % greater than SF bay tides and is used to determine predicted range.
Source: Regression equations modified from Williams et al. (2002).

figure 4
PSNERP

Channel depth hydraulic geometry

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c) add the fluvial volume to the tidal prism to get the increased effective tidal prism c,

d) and e) locate the corresponding adjusted cross-sectional area.

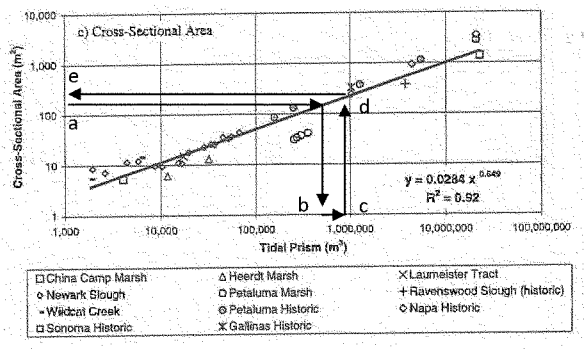


Figure 5: Tidal Prism vs. cross-section area (Williams et al, 2002); with example for adding minor drainage to increase effective tidal prism

The adjusted cross-sectional area can be accomplished by increasing the channel width, and assuming the depth does not increase.

The fluvial flow rate used in the calculation is selected by the designer. For summer conditions, this would be base flow. Otherwise, the estimated channel-forming flow, perhaps in the range of annual to 5 –year recurrence, can be used.

This procedure for increasing channel section for stream discharge can also be used to estimate the size of larger channels to convey the initial (post restoration) tidal prism of subsided sites. Typically, the future equilibrium tidal prism and channel dimensions are adequate and practical for restoration. However, the additional tidal prism for subsided sites can be estimated approximately as the site area times the difference between site grade and the MHHW elevation. This additional tidal prism can be added to get the expanded tidal prism "c", and the expanded channel dimensions estimated.

It should be noted that these are approximate dimensions intended to accommodate site evolution toward equilibrium, rather than equilibrium geometries.

Channel Order and Drainage Area

Channel order is a means of comparing the number of channels of different size within and between drainage networks. The hierarchy of channel segments starts with the smallest channels and increases in order when two channels of the same order connect. For example, when two first order channels join, the downstream segment is classed as second order. When two second order channels join, the

downstream segment becomes third order. A first order channel joining a third order channel does not change the order of the downstream segment. The system is defined by the highest order of channel; for instance a tidal drainage network may be described as 'third order'.

Horton (1945) found that channel order is related to a number of metrics describing the channel network:

- number of channel segments;
- segment length;
- drainage area.

Generally these relations are semi-logarithmic as seen Figure 6 that plots drainage area with channel order for marshes in Snow Creek and Salmon Creek (Barnard, pers comm.).

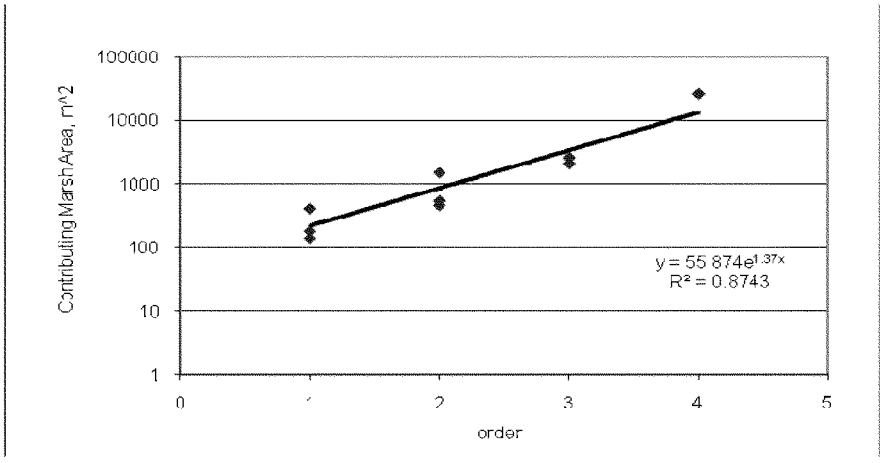


Figure 6: Regression of tidal channel order and marsh drainage area. Source: Salmon Creek data and analysis by Bob Barnard, WDFW.

General guidance can be provided from observations of natural channel systems of similar area; use should be made of local reference sites where possible. The following guidance is based upon marsh channel data and experience in constructing marsh channels:

a) Use the historical channel patterns, if it exists;
b) For drainage areas of 10 to 50 acres, a third or fourth order channel system should be adequate;
c) Second, third and fourth order channels should be excavated to equilibrium depth;

d) First order channels may not be practical to cut, especially if the site is subsided and expected to accrete sediment;
e) If the site is being graded, the marsh slope should be graded down below MHHW and sloped towards the channels to allow drainage and encourage channel network development.

3. Intertidal - Fluvial (channel modification, dike removal)

Given the paucity of data available, design guidelines for tidally-influenced fluvial channels is not practical within the time and budget constraints of this project. Hence, we recommend use of historic maps of the site, dimensions of remnant channels, and measurements at nearby reference sites if available.

4. Tidal Inlet (coarse sediment) (Channel Modification, Dike Removal, Hydraulic Connection)

Hydraulic geometry relationships between tidal prism and the cross-sectional area of the inlet channel are perhaps the most common criteria applied to predict the stability of tidal inlets (Battalio, et al, 2006). These are empirical relationships based on surveys of stable inlets and take the form:

$$A_e = C\,\Sigma^n$$

where A_e is the minimum cross-sectional area, Σ is the tidal prism, and C and n are empirically derived parameters. Jarrett (1976) examined earlier work by O'Brien (1931) for Pacific Coast inlets, and established relationships for sites along the Gulf, Pacific and Atlantic coasts. His results were further divided among inlets with and without jetties. Although the expressions established by Jarrett are considered the best available predictors for equilibrium cross-sectional areas, small inlets (small inlets can be defined as those with thalwegs near or above MLLW) tend to exhibit equilibrium area much larger than predicted by these tidal prism relationships (Hughes, 2002).

The cross-sectional area of the inlet channel, A_e, is related to the effective tidal prism by:

$$A_e = 0.65 k_a (C_I P)^{8/9}$$

where

$$C_I = \frac{W^{1/8}}{[g(S_S - 1)]^{1/2} d_e^{3/8} T}$$

W is the inlet width at mean tide level (meters), T is the tidal period (typically use semi-diurnal 12.4 hours, which is 44,640 seconds), d_e is the median grain size (in meters), g gravitational acceleration (9.81 m/sec^2), k_a is an empirical coefficient (with a best-fit value of 1.34), and P is the effective tidal prism (cubic meters). S_s is the specific gravity of the sediment (ρ_s / ρ_w) which is often taken to be around 2.6 for quartz and other rock.

The highest point in the channel thalweg typically occurs as the channel crosses the flood shoal and controls the low water elevation in the marsh. Relatively large wave events can induce a control at the receiving water side (eg. the ebb shoal or spit in Puget Sound) as well. Due to the complexities of ebb and flood shoal geometries and the difficulty in field data collection, the narrowest, deepest section of the inlets (aka "throat") are typically used as the reference section. Figure 7 shows the general relationships measured at the Crissy Field Lagoon "throat" in San Francisco Bay. The key parameter is the lagoon low water, which controls the effective tidal prism of the lagoon. The lagoon low water is

variable, as it results from the sill elevation formed bay wave transport of littoral sediments against the scour of ebb tides. Inlet morphology also has an effect, which is greatly influenced by littoral drift parameters including structural controls such as reefs and jetties.

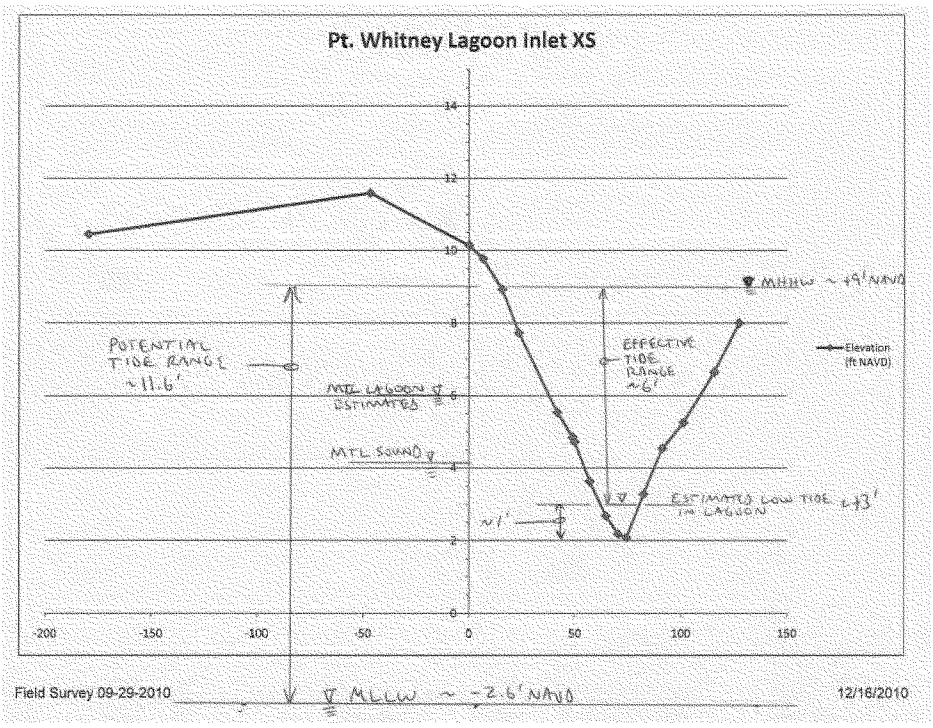


Figure 7. Effective tide range and inlet cross-section.

Considerable scatter in the data suggest that not all of the relevant processes are included in these simple relationships. Therefore, they should only be used as a first approximation and interpreted as representative of long-term average conditions. Significant variations in inlet cross-section can occur over the spring-neap tide cycle, during storms when wave attack is more intense, or following large flood events (DeTemple, 1999). This is especially true for small dynamic systems. A process-based tidal prism relationship developed by Hughes (2002) shows better agreement between small and large tidal inlets, and more promise for application to Puget Sound lagoons (Figure 8).

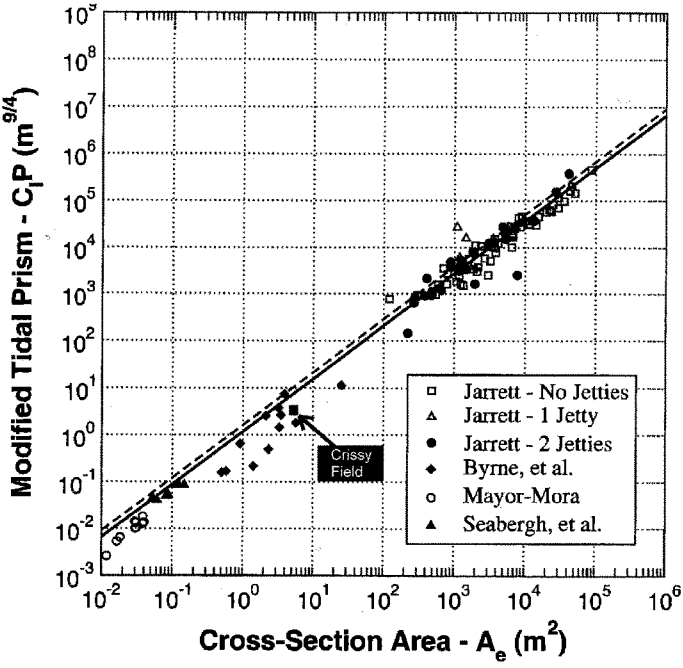


Figure 8. Hughes (2002) tidal prism and inlet cross-section relationship.

It should be noted that the sediments in Puget Sound are typically much coarser than those used to develop these empirical relationships. Coarser sediments tend to have greater porosity and hence can allow greater discharge through the berm, indicating smaller inlets may be likely. Coarser sediments also tend to form higher, steeper beach berms under wave action, which tend to resist deep thalwegs and hence shallower inlets can be expected. Finally, coarse sediments do not move as quickly for a given wave climate, and hence Puget Sound inlets will likely be more stable. In summary, we expect Puget Sound inlets to be shallower and more stable, with greater outflow through the littoral barrier.

Applications of the O'Brien and Johnson methods can be improved with accurate estimates of wave and tidal power. Figure 9 shows the corrected data in the form previously reported by Williams & Cuffe (1994) for California lagoons. We believe the version shown below can be used generally with contemporary wave power values (prior published versions had wave power values about 200 times too high (PWA, 1999)).

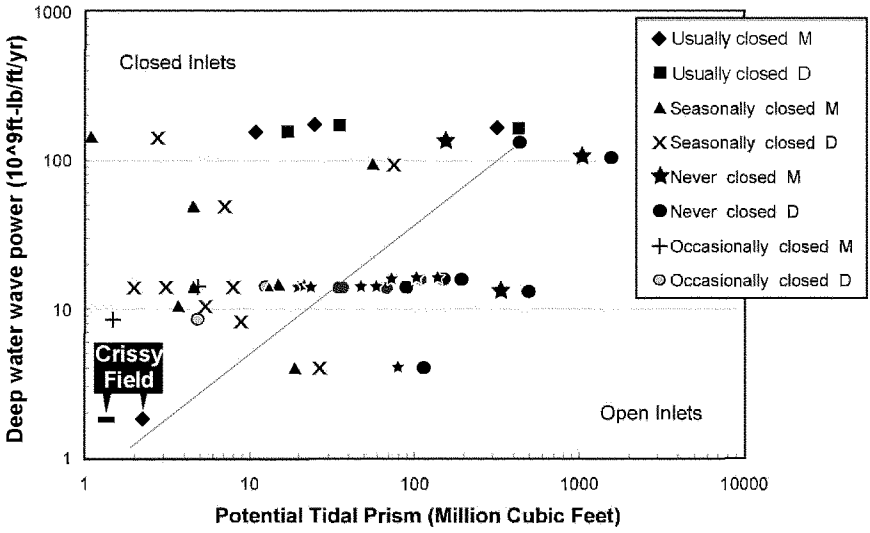


Figure 9. Power-based index of inlet closure potential with corrected annualized wave power. "M"=Mean tidal prism and "D"= diurnal tidal prism.

Ideally wave power would be calculated from the wave climate. Since much of the Sound is relatively deep with short fetches, relatively short wave periods can be expected. Exceptions are the Straits of and Juan De Fuca and Georgia where swell (Juan De Fuca)and large wind waves can occur (Strait of Georgia, Coulton et al, 2001): For these locations, more detailed calculations are recommended. For the Strait of Juan De Fuca, wave data are available. In most sites, wind wave hindcast using fetch limited parametric equations and wind climate is sufficient to define the deepwater wave climate. Simplified wave refraction using Snell's law and diffraction using the methods of Goda (1985) are adequate. These data exist for some sub basins but otherwise may be beyond the scope of the PSNERP conceptual designs.

Wave power can then be used to estimate the minimum tidal prism needed to maintain an open inlet, using Figure 9. Note that Figure 9 is based on the potential tidal prism, which is typically the lagoon size multiplied by the potential tide range. Dividing by the tide range can then give an estimate of minimum lagoon size required for an open inlet. However, the actual tidal prism, often called the effective tidal prism, will be reduced by the littoral ridge built by waves. The effective tidal prism and tide range are "implicit" within inlet equations and can be the most challenging parameters to estimate. For open lagoons, a first estimate can be made by multiplying the lagoon area times the depth below MHHW (assuming the site bed is above MLLW). Note that the littoral sill often prevents full drainage, so using the existing grade as an estimate of the low tide may lead to an over-estimate of effective tidal prism and inlet area. For marshes, a first approximation can be based on the methods in Section 2 of this document. Also, like marshes, fluvial discharge tributary to the site can increase inlet size above that

based on tidal prism alone. Once the effective tidal prism is estimated, it will be used to estimate the required inlet cross section geometry using Figure 8 and selected aspect ratios (width to depth).

The best available relationship for small tidal inlets in littoral systems is Hughes (2002; Figure 8). A review of this equation indicates that it is very sensitive to grain size, with larger grain sizes resulting in smaller predicted inlet cross sections. We recommend using a default of 1 mm which will help keep the equation within the range of data sources and bias the area calculation to the high side: In general, over-excavation of the inlet results in less risk of subsequent closure. Further research is needed to inform use for coarse sediment shores.

It should be noted that over-excavation will induce a perturbation that can reduce sediment supply to adjacent shores. Excavated sediment compatible with the littoral sediment should be placed down drift to mitigate the subsequent interruption of longshore transport during inlet evolution. For new inlets, placement of littoral sediments should be considered to mitigate the sediment deficit induced by flood and ebb shoal formation. The effect can extend updrift as well but to a lesser extent.

Once area is calculated, width and depth are selected. Ideally, an estimate of one of these parameters will be available. For example, the inlet width from an historic map can be used, and then the depth can calculated based on an assumed shape (see below).

The equation for a channel with a parabolic shape is as follows:

$$W=1.5A/d$$

Where W = width, A = area and d = depth.

Deepening of an existing inlet due to increased tidal prism can be estimated by prorating the existing depth using the square root of the estimated increase in cross-sectional area. Assuming that the width-to-depth ratio of the inlet throat remains the same, changes in depth of the throat can be estimated from:

$$\frac{d_{new}}{d_{old}} = \sqrt{\frac{A_{e\,new}}{A_{e\,old}}}$$

where d is the maximum depth at the throat, measured below $MTL_{lagoon,}$, and Ae is the area defined above for the Hughes (2002) relationship.

The depth of the inlet channel below Mean Tide Level (MTL) has been approximated using the relationship between depth and inlet area devised by Vincent and Corson (1981):

$$D_m = 0.5579(A_c)^{0.38}$$

where D_m is the depth at the throat of the inlet below MTL (ft) and A_c is the inlet below MTL (ft^2). This relationship was developed from data in Chesapeake Bay (Virginia, USA) which has a much smaller tide range, a semi-diurnal tide, and much finer sediment. Hence, this relationship should be used as an indicator to inform design judgment. For smaller systems, this equation may under-predict the depth

due to its derivation with data from areas with smaller tide ranges. If this equation is used and predicts depths significantly above MLLW, over-excavation is recommended.

Reference site data can be used instead of or in addition to the methods proposed here.

5. Beach (coarse sediment) (bulkhead removal, groin removal)

The morphology of coarse sediment beaches includes a steep foreshore (swash zone) leading up to a flat terrace or berm (Bauer, 1974; Lorang, 2002). The profile morphology and terms are shown by the example in Figure 9 (Birch Bay, Whatcom County, Bauer, 1975). The swash zone slope is affected by sediment size and wave climate. For most Puget Sound locations, the swash zone has a typical slope around 7:1 with a range between 5:1 and 10:1 (horizontal: vertical). Steeper slopes can be expected for coarser and more uniform sized sediments, and higher wave exposure. The berm elevation is typically considered the result of wave runup that builds the berm to a level just below the annual maximum total water level (total water level is defined as the Puget Sound water level plus wave runup).

Figure 10 shows a conceptual profile of coarse beach dynamics (Bauer, 1975). Note that Figure 10 shows a berm configured to provide protection to inland development and includes extra volume as a "storm buffer," with the berm crest elevation about 6.5' above MHHW. Given PSNERP's focus on restoration, berm heights should typically not be over-built for protective purposes. Figures 11 and 12 provide an example of a reference site in Whatcom County (PWA, 2002). The berm crest is around 11.3' to 12.8' NAVD (converted from NGVD by adding 3.8'), and about 4 feet above MHHW. Note the wood above the berm indicating that the total water level exceeds the berm crest in natural conditions. Therefore, we recommend under-building the berm slightly to allow shaping by wave action. Slight under-building avoids the potential adverse effects of unnatural morphology and while limiting sediment demand to fill the "void" resulting removal of fill or armoring.

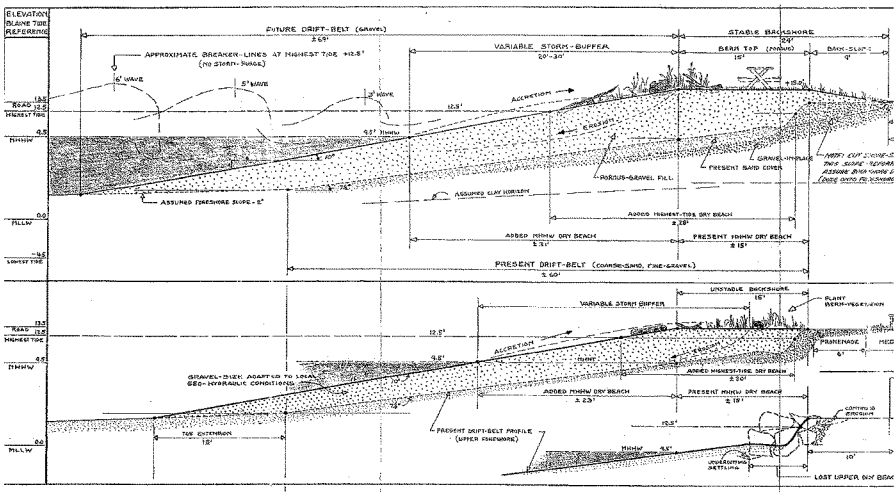
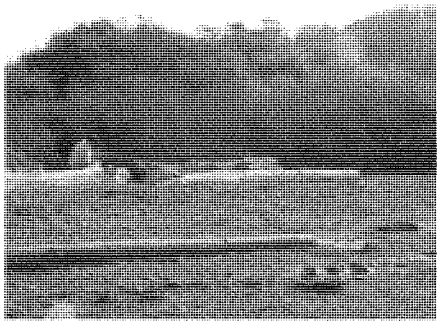
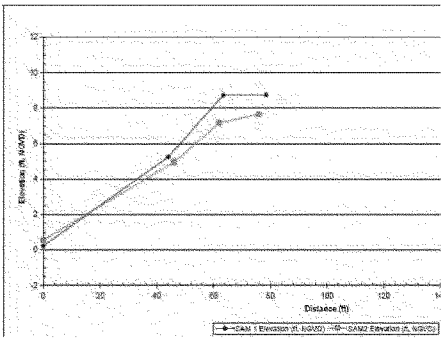


Figure 10. Description of coarse sediment beach profile morphology, for a protective berm (Bauer, 1975).





Figures 11 and 12. Semi-Ah-Moo Beach. Photograph of beach swash zone and berm (left); Elevation cross sections of swash zone slope and berm (right). Source, PWA, 1975.

For PSNERP conceptual designs, the geometry of nearby reference sites can be used to develop the restored profile and estimate quantities. Alternatively, some basic parameters should be sufficient. A slope of around 5:1 to 10:1 with a typical of 7:1 is recommended. This should be checked and adjusted based on consideration of local geometry, reference sites, size of sediment and wave exposure. The berm elevation can be estimated as the height of the annual wave runup (R) on the profile using the following equation:

$$R_{2\%} = \text{Static Setup} + \text{Runup}$$

$$= 0.2\ H_0 + 0.6r\ (m/(H_0/L_0)^{1/2})H_0$$

The above equation is based on the surf similarity parameter / Iriabarren number; m is the beach slope, r is an empirical coefficient, H_0 is the significant deep water wave height and L_0 is the deep water wave length . The wave values used should be on the order of an annual to 5 year return period. (Note that the term "2%" for the runup does not refer to annual frequency, but rather the exceedance within an event, e.g. the significant exceedance is typically considered 33% and the rms 50%).

It is recommended that a composite slope of about 10:1 (m=0.1) is used to account for larger waves breaking offshore of the swash formed foreshore. Also, the result should be adjusted downward to account for the permeability of the coarse sediment and a factor of about r=0.8 is recommended.

Wave runup on natural beaches does not typically exceed about three times the wave height. For steeper waves on porous (gravel, cobble) sediments, the runup is reduced and a maximum of about two times the wave height can be expected. We therefore recommend that a reasonable range for runup in sheltered waters (not exposed to ocean swell) is between 0.5 and 2 times the wave height, and on coarse sediment shores (gravels and cobble) will not typically exceed 1 times the wave height.

Since the berm is formed by the total water level with an approximate annual exceedance, the more extreme wave runup value (1 to 5 year recurrence) should be added to a typical high tide, on the order of MHHW or MHHW with a surge / setup added: A setup due to meteorological effects can be on the order of 1 foot. Alternatively, an annual high water level can be combined with a smaller, nominal wave height likely to occur simultaneously with the high tide.

For cases where much larger waves break far offshore of the berm, wave setup for the larger offshore waves should be added. A static wave set up can be approximately estimated as 0.2 times incident wave height (FEMA, 2005). The groupiness and randomness of the waves also results in longer-period dynamics often called dynamic setup. Accounting for dynamic setup and combining with static setup and runup can be complex. However, for the conditions associated with PSNERP it is recommended that a total wave setup of about 0.3 times the deepwater wave height is a reasonable estimate of total setup due to larger waves breaking offshore.

We recommend a minimum beach berm elevation of 1.5 ft above MHHW.

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Appendix A: NAVD Conversions from Pacific Survey and Engineering, 2010

Bob Battalio

From: Adam Morrow [AMorrow@psesurvey.com]
Sent: Tuesday, November 30, 2010 9:35 AM
To: Margaret Clancy
Cc: Bob Battalio
Subject: PSNERP Datum Conversions
Attachments: PSNERP_DATUM_CONVERSIONS.pdf

Margaret,

In an effort to wrap up our work on this project to date and provide you with an item that had been discussed in some detail over the past few months, we have attached a spreadsheet that details our Tidal-NAVD 88 vertical datum conversions that can be used for pre-selected sites. The spreadsheet includes conversions for areas that were noted as not available in Bob Battalio's previously emailed spreadsheet.

With a few exceptions, we were able to find consistent datum conversions for tidal regions throughout Puget Sound. Where we could not, we listed the applicable VDATUM conversion related to the reference tidal gauge. For your use, we also included a column that indicates our level of confidence for each conversion, based on the availability of published benchmark information and/or conflicts between published data and VDATUM results.

We hope that this proves useful for the design team in the continued efforts to provide 10% design documents for the project. We are ready and willing to respond to questions about this information as needed to help you complete your Phase 2 work.

I look forward to hearing from you in the near future about opportunities to continue to provide services on this project. From our research work to date, I suspect that we now have a good database of information from which we can provide cost estimates for necessary survey and base mapping work at each site if that is deemed necessary.

Thanks.

-Adam

Adam Morrow, PLS
Pacific Surveying and Engineering
1812 Cornwall Avenue
Bellingham, WA 98225
(360) 671-7387
(360) 671-4685 (fax)

	NOAA TIDAL REGION	POINTS IN COMMON (NGS)	Station Lat.	Station Long.	SEPARATION NAVD-TIDAL* US FEET	SEPARATION VDATUM** RESULT	TIDAL EPOCH	CONFIDENCE LEVEL***
Cherry Point	9449424	1	48 51.8 N	122 45.5 W	**0.96**	0.96	83-01	2
Friday Harbor	9449880	3 (WSDOT)	48 32.8 N	123 0.6 W	**0.53**	0.38	83-01	3
LaConner, SS	9448558	1	48 23.5 N	122 29.8 W	**1.51**	1.51	83-01	4
Crescent Bay	9443826	1	48 9.7 N	123 43.5 W	**0.42**	0.42	83-01	4
Pt Townsend	9444900	2	48 6.7' N	122 45.5' W	**1.11**	1.12	83-01	4
Seabeck, HC	9445296	0	47 38.5' N	122 49.7' W		**2.62**	83-01	1
Yoman Pt, Al	9446705	0	47 10.8' N	122 40.5' W		**3.78**	83-01	1
Barron Pt	9446742	0	47 9.4' N	123 0.5' W		**4.08**	83-01	1
Budd Inlet	9446807	0	47 5.9' N	122 53.7' W		**4.05**	83-01	1

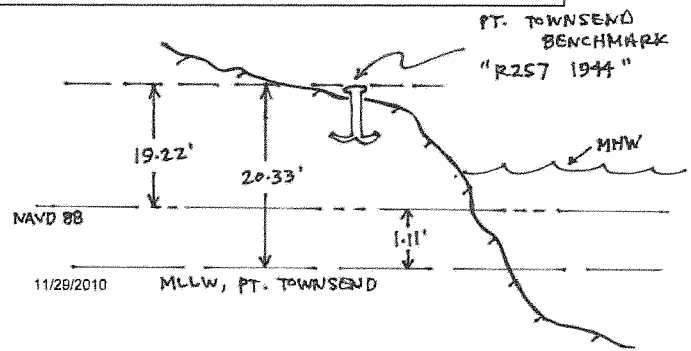
* Conversions determined from published elevations on benchmarks in common between NOAA, WSDOT and NGS.

** Conversions determined using VDATUM, a software tool developed jointly by NOAA's NGS, OCS and CO-OPS.

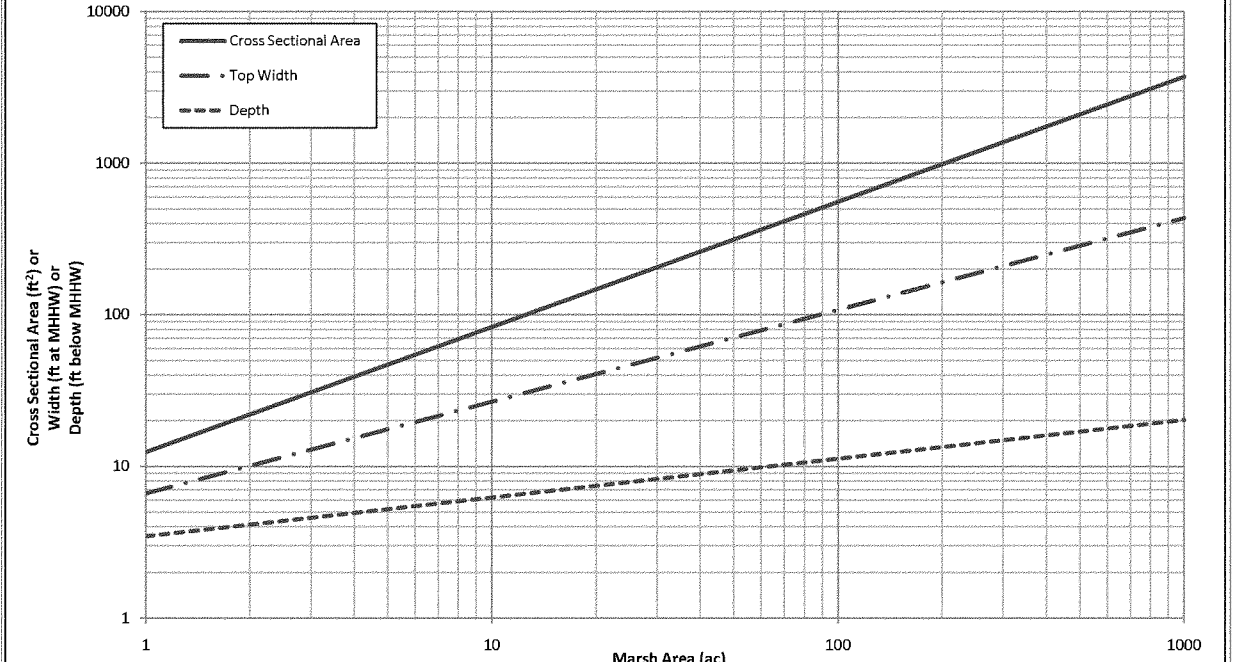
*** Level of confidence in conversion values based on # of sources found and agreement between sources. 4=highest, 1=lowest.

HOW TO APPLY CONVERSION:

Throughout the region, the 0 elevation plane of NAVD88 is above the 0 elevation plane of the various tidal datums. As a result, the NAVD88 elevation at any given point should reflect a smaller value than the local tidal datum elevation at the same point. To convert from tidal to NAVD88, subtract the separation value noted above in any given region. To convert from NAVD88 to local tidal datum, add the separation value. See sketch below:



Appendix B: Graphs of Tidal Wetland Channel Dimensions vs. Marsh Area



Tide Gage Station: Cherry Point # 9449424
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **1**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Cherry Point

PWA Ref #: 2036.00

PWA

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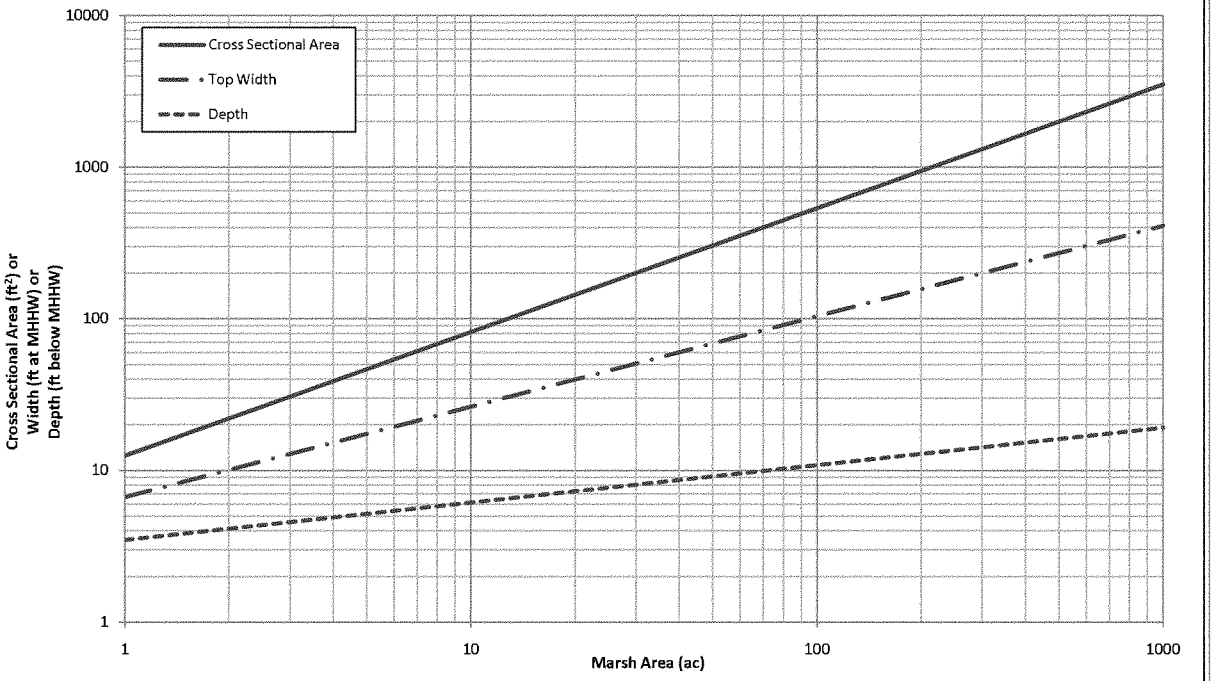

Tide Gage Station: Bellingham # 9449211
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure 2

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Bellingham

PWA Ref #: 2036.00

PWA

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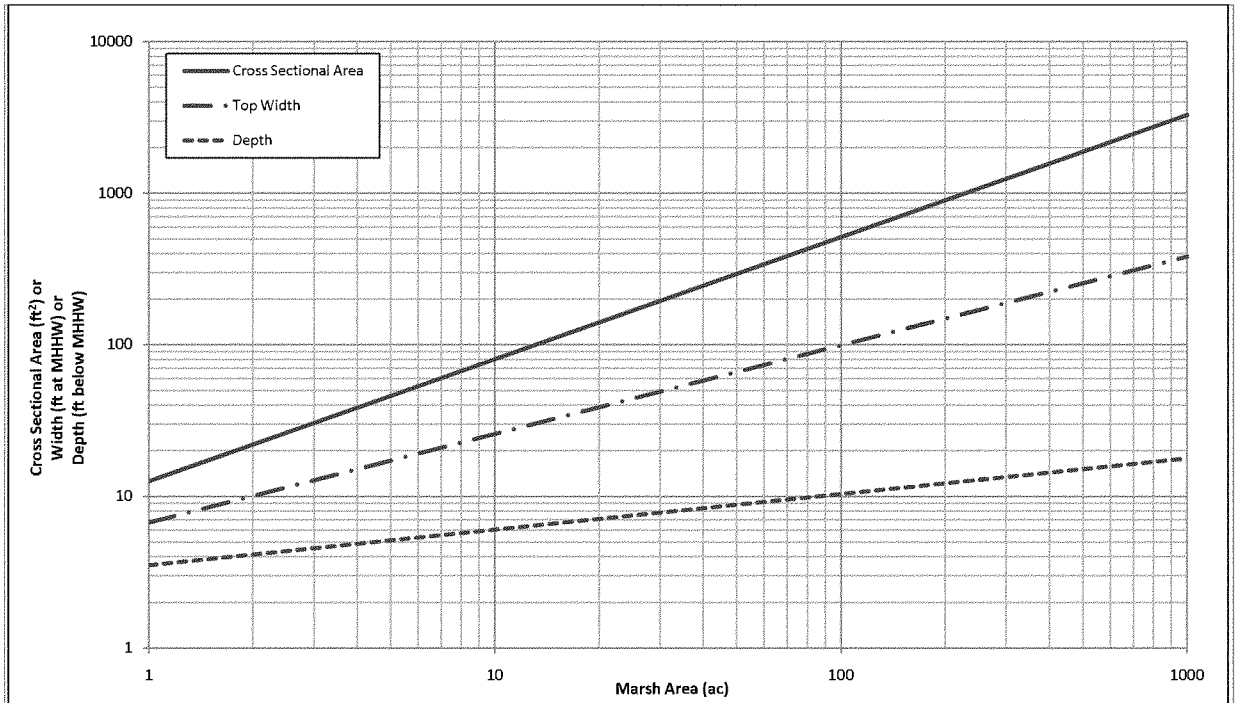

Tide Gage Station: Friday Harbor # 9449880
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **3**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Friday Harbor

PWA Ref #: 2036.00

PWA

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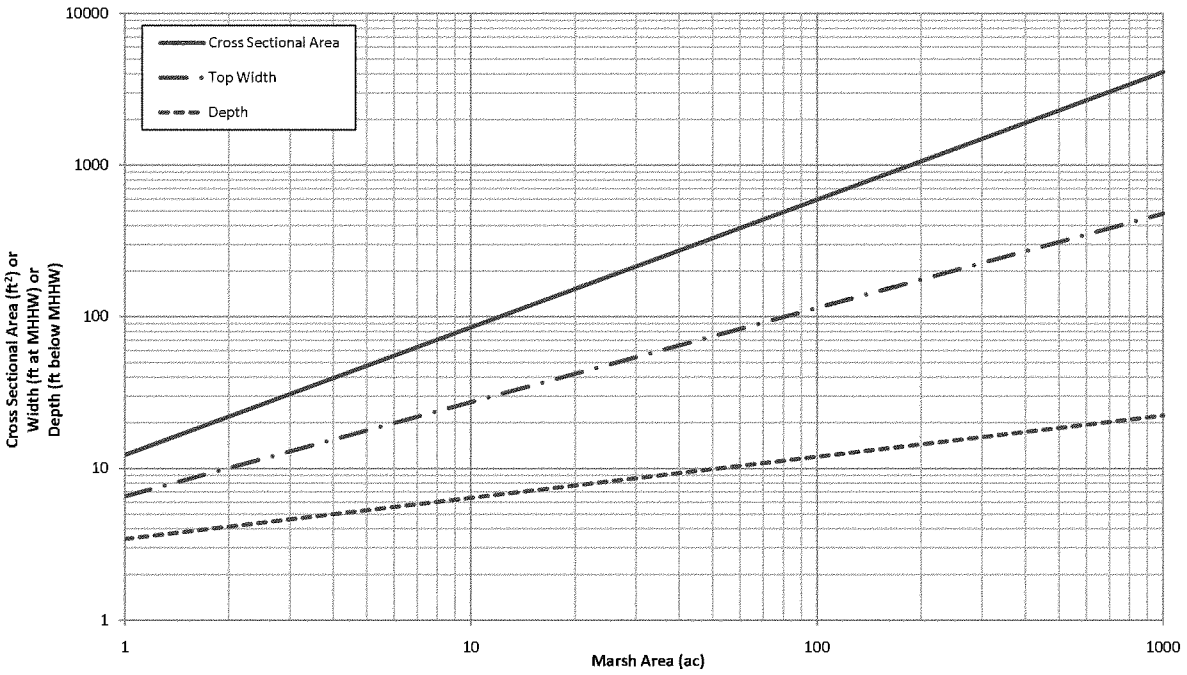

Tide Gage Station: La Conner, Swinomish Slough # 9448558
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure 4

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for La Conner, Swinomish Slough

PWA Ref #: 2036.00

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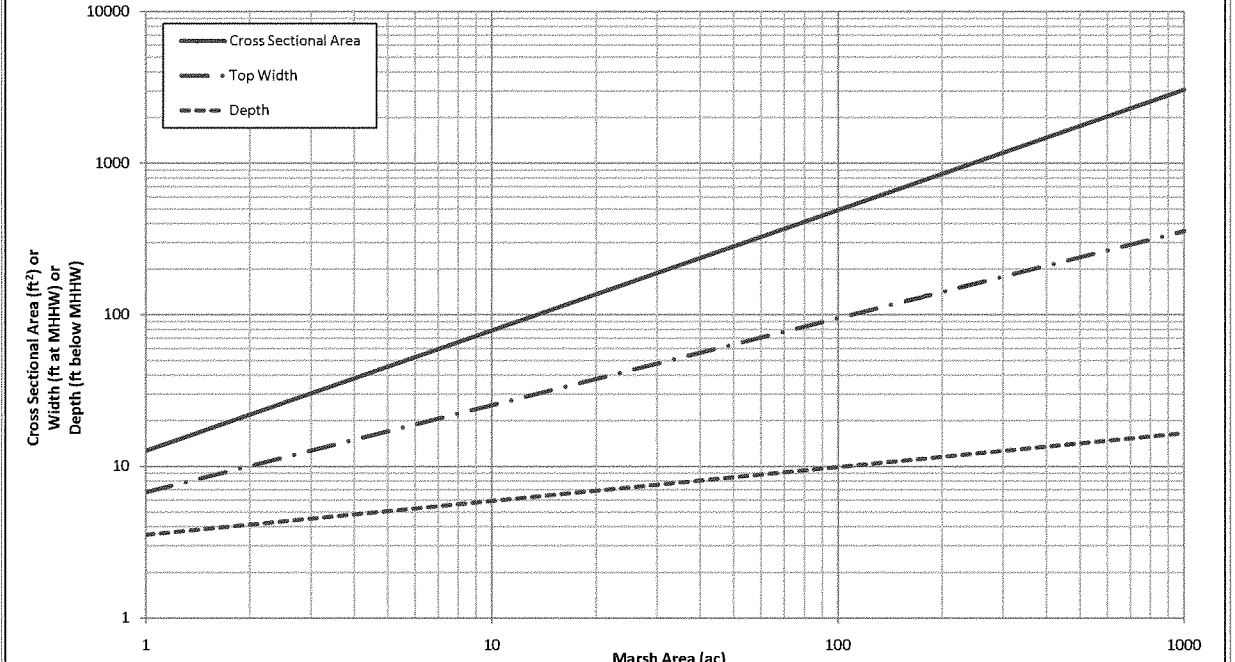

Tide Gage Station: Crescent Bay # 9443826
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **5**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Crescent Bay

PWA Ref #: 2036.00

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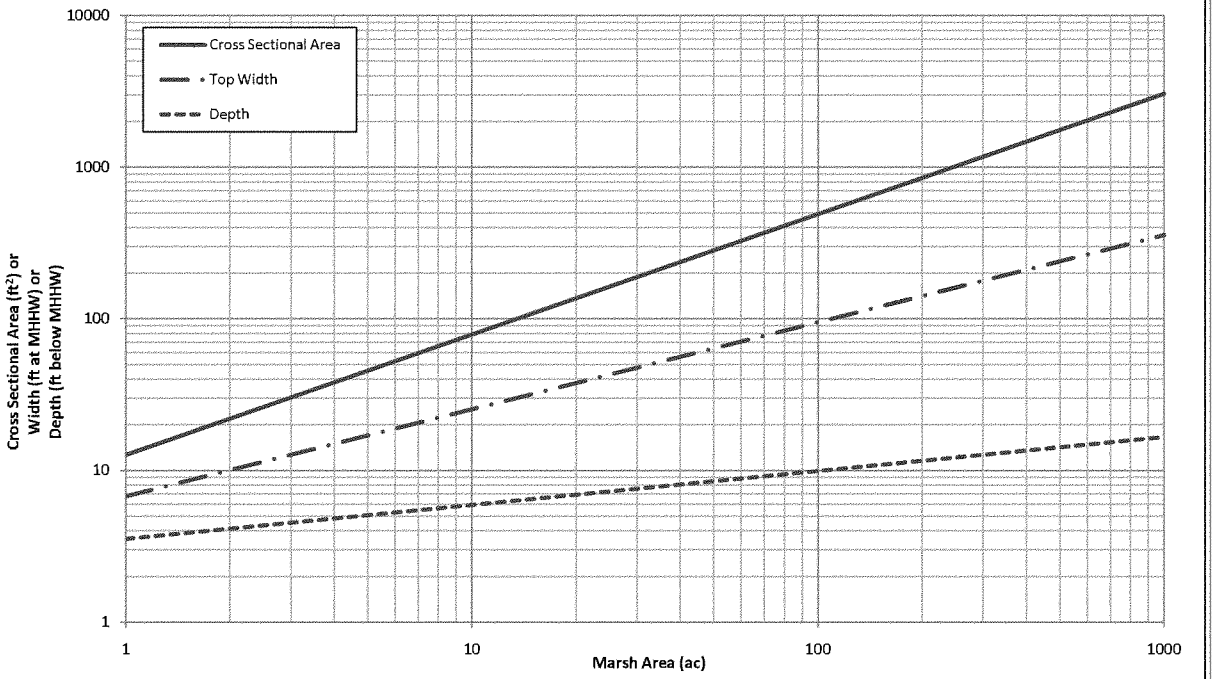

Tide Gage Station: Port Angeles, WA # 9444090
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **6**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Port Angeles, WA

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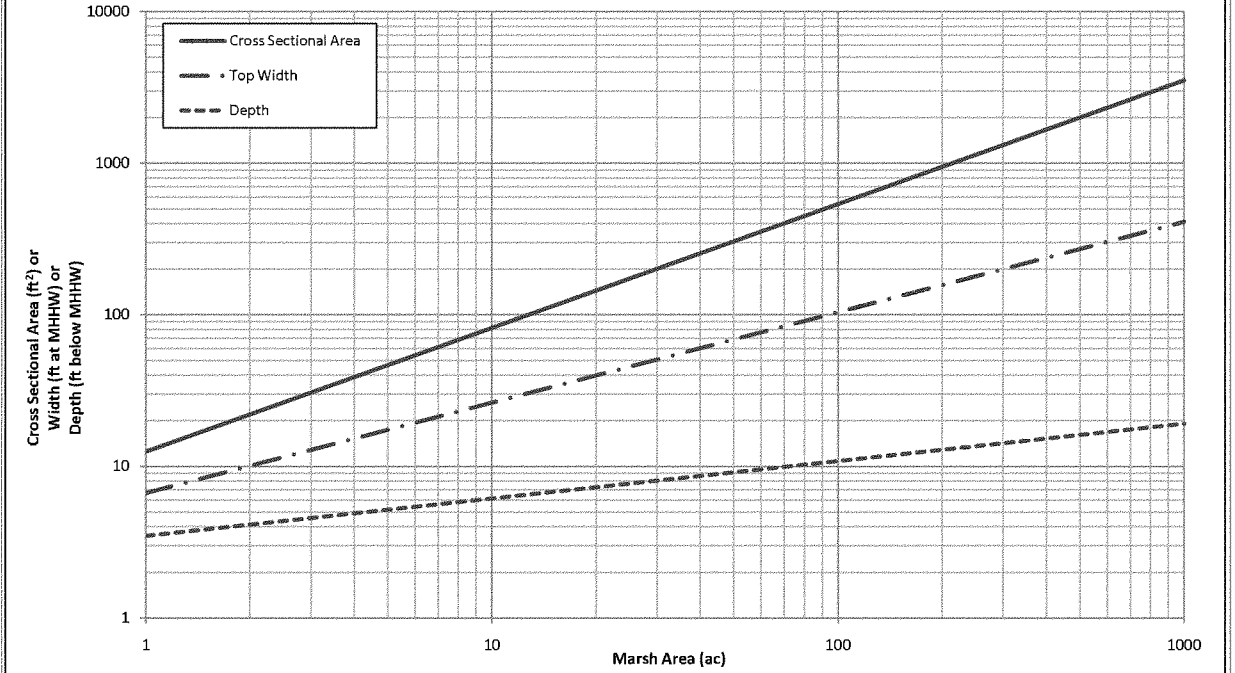

Tide Gage Station: Port Townsend # 9444900
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure 7

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Port Townsend

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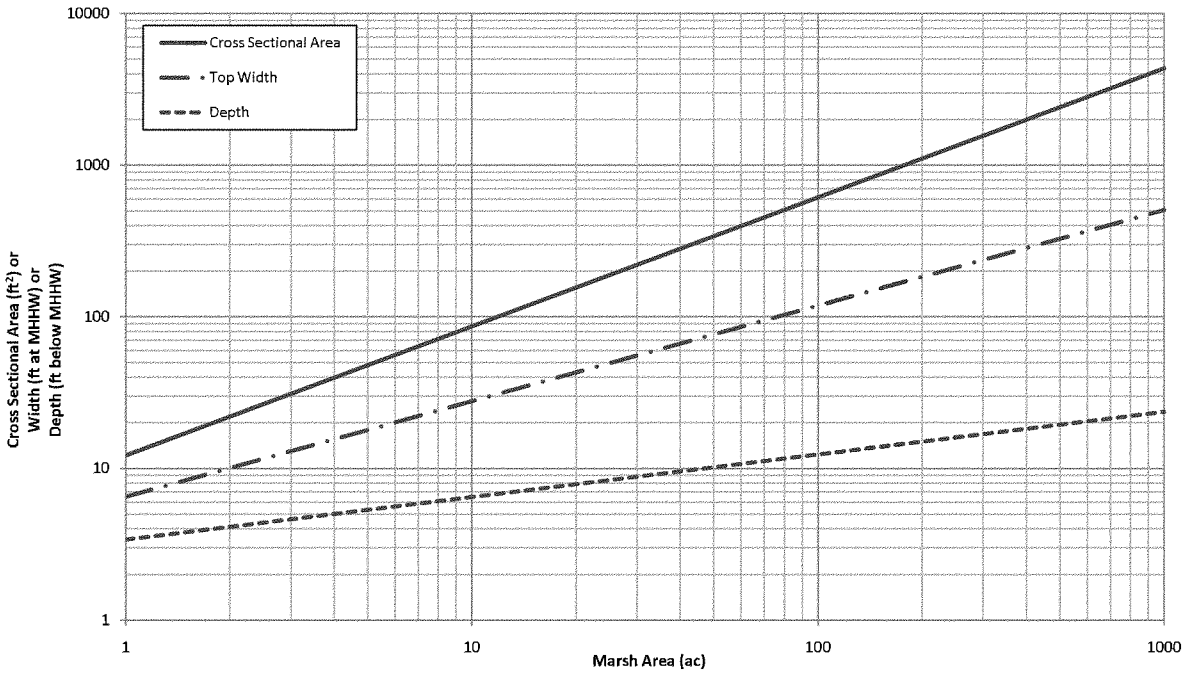

Tide Gage Station: Everett, WA # 9447659
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **8**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Everett, WA

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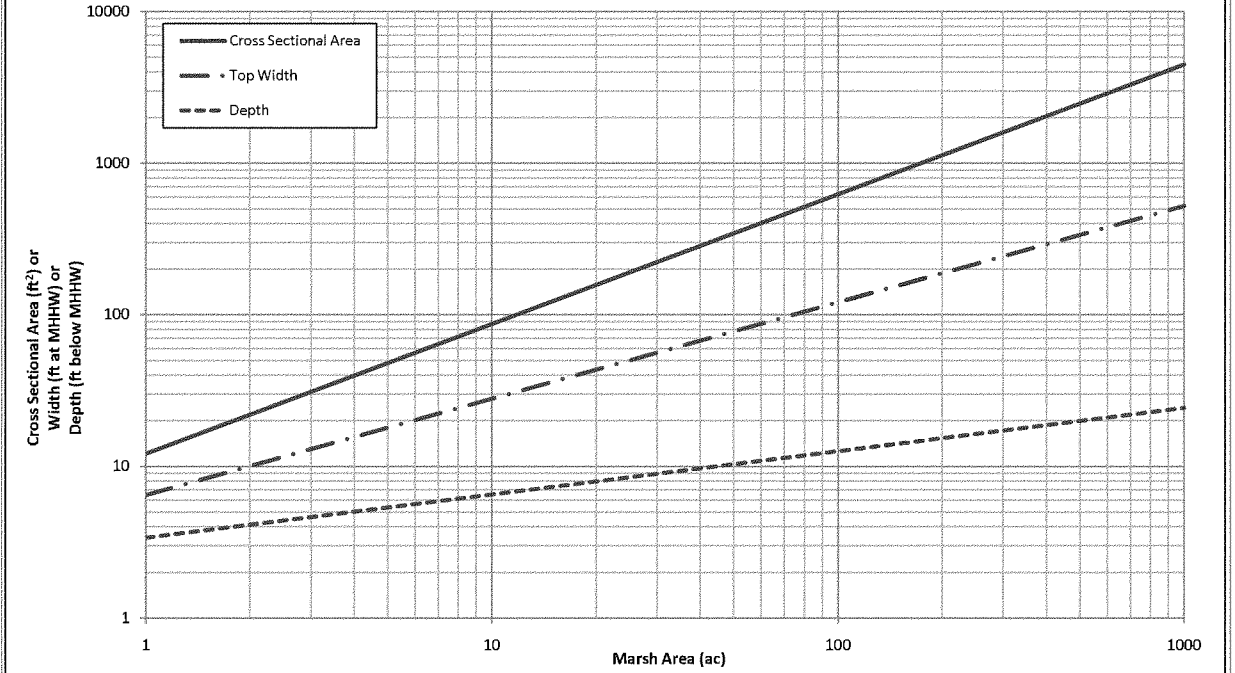

Tide Gage Station: Seabeck, Hood Canal # 9445296
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **9**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Seabeck, Hood Canal

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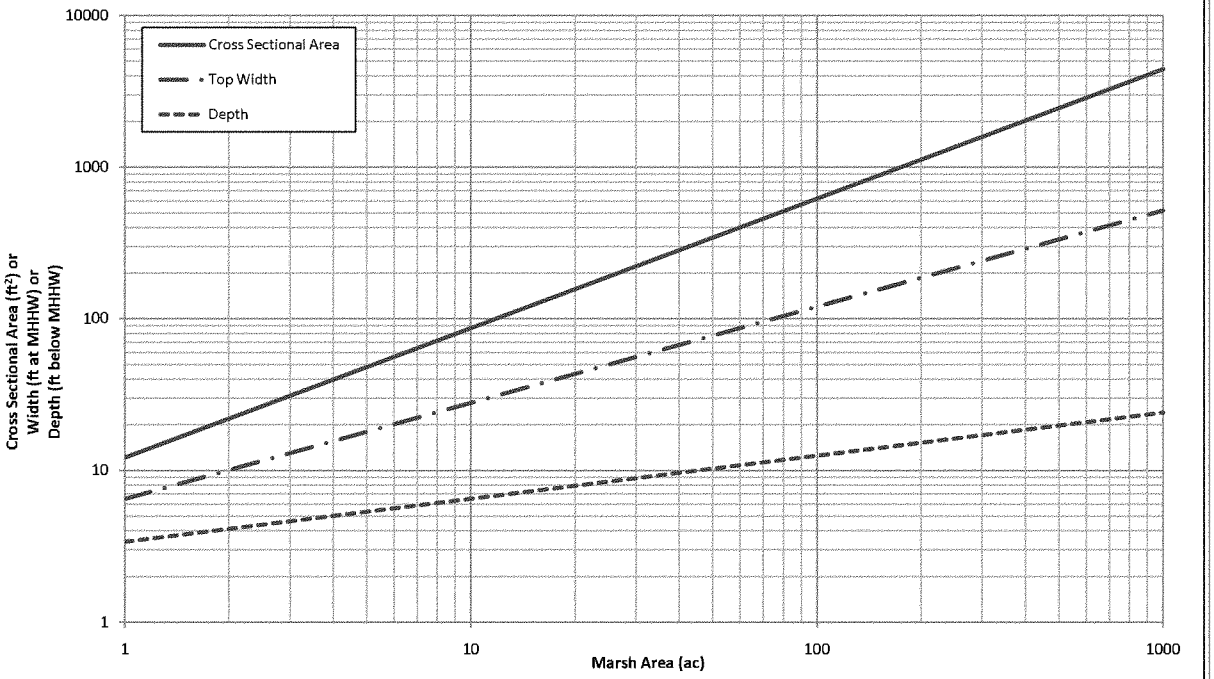

Tide Gage Station: Seattle, Puget Sound # 9447130
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **10**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Seattle, Puget Sound

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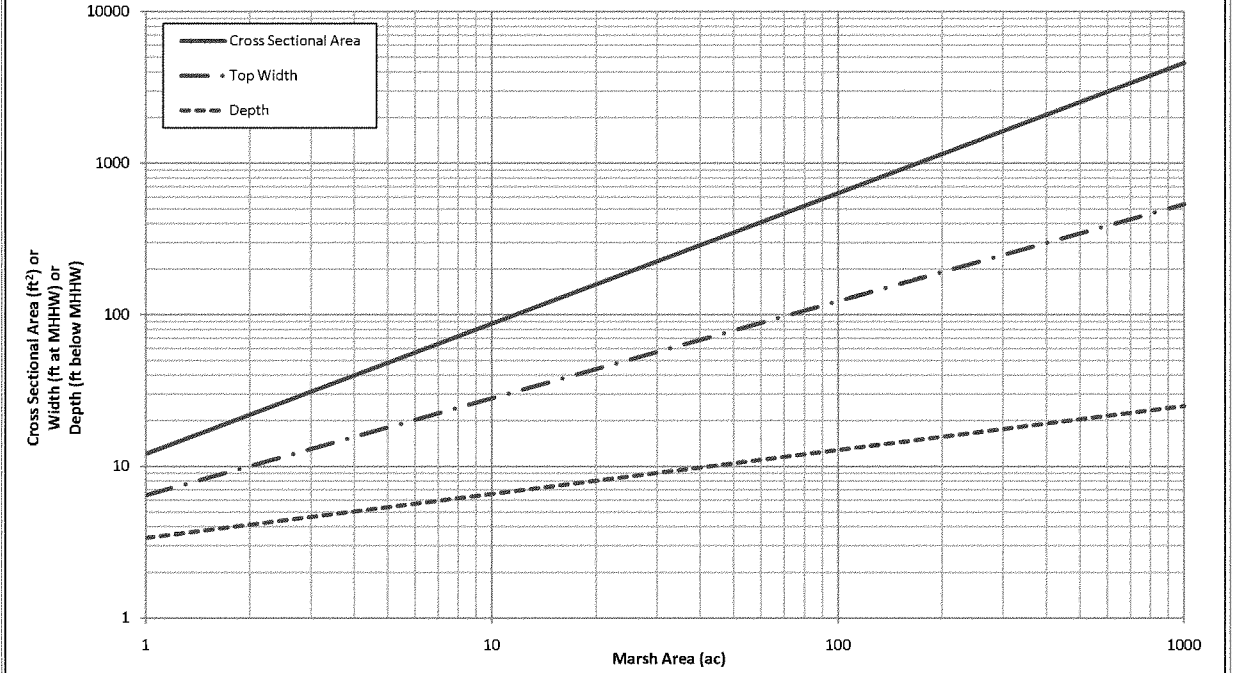

Tide Gage Station: Union, Hood Canal # 9445478
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **11**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Union, Hood Canal

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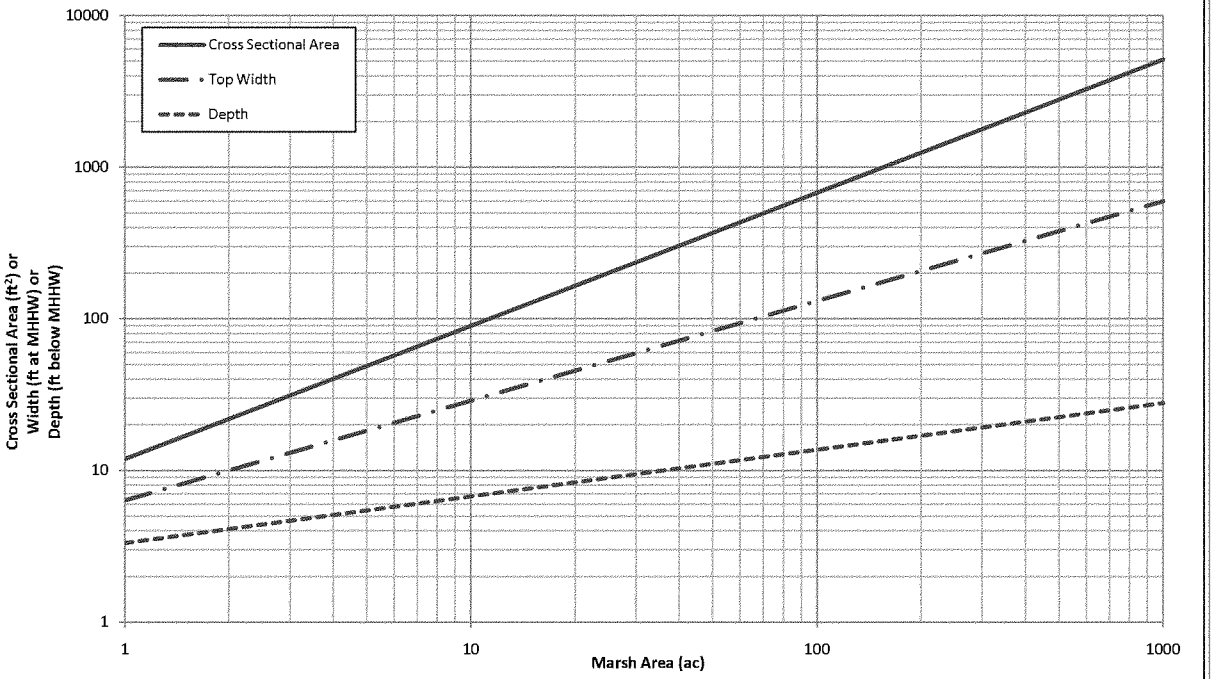

Tide Gage Station: Yoman Point, Anderson Island # 9446705
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **12**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Yoman Point, Anderson Island

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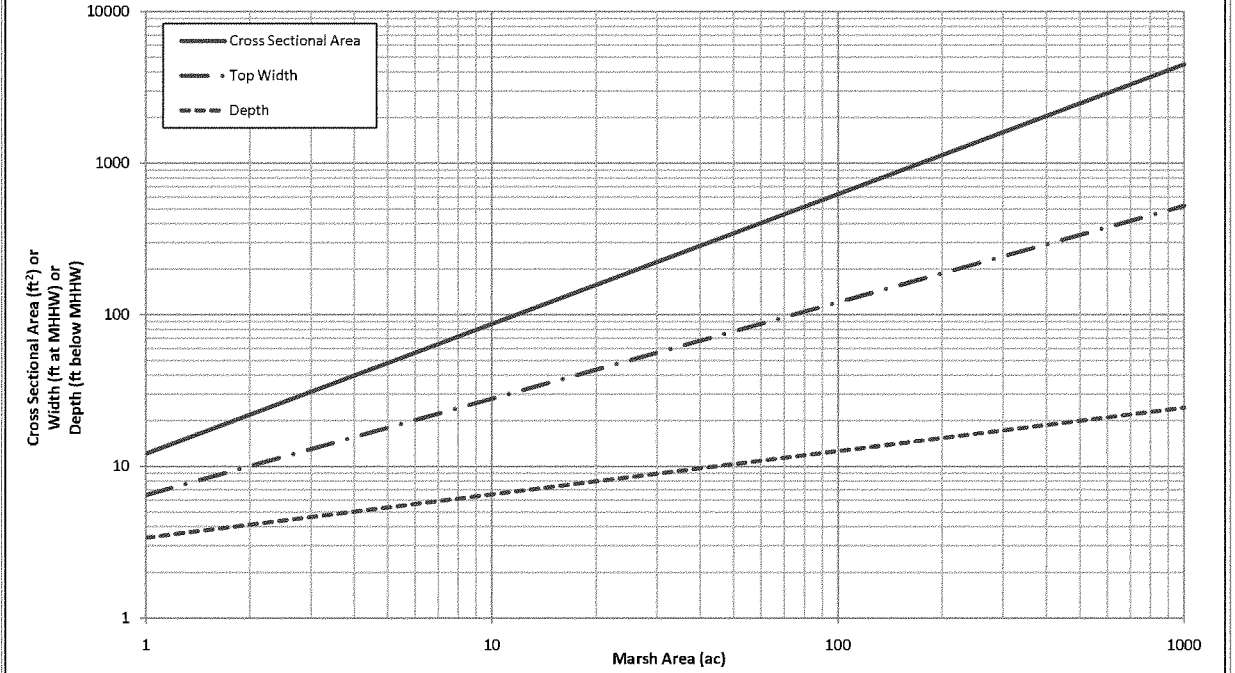

Tide Gage Station: Barron Point # 9446742
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **13**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Barron Point

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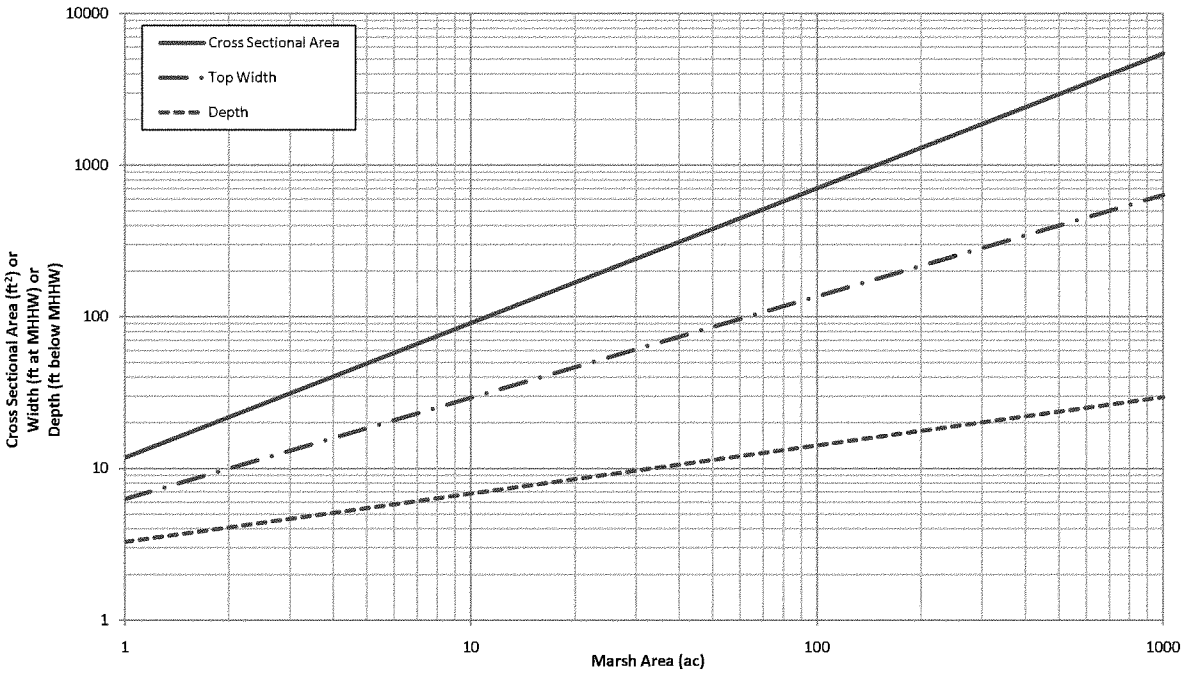

Tide Gage Station: Budd Inlet # 9446807
For 10% PSNERP design use only.

Source: Williams et al. (2002). Regression equations adjusted based on percent increase in diurnal tide range relative to San Francisco Bay.

figure **14**

Puget Sound Nearshore Ecosystem Restoration Project

Hydraulic Geometry for Budd Inlet

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memorandum

date December 22, 2010

to Bob Barnard, Curtis Tanner, PSNERP Conceptual Design Team

from Phil Williams and Jeremy Lowe

subject PSNERP - Hierarchy of Benefits

1. INTRODUCTION

The purpose of this memo is to describe a hierarchy of benefits that will likely accrue to the natural processes, structure, and function of an ecosystem for variously located and sized openings in crossings of tidal and tidally influenced fluvial channels. We describe benefits in terms of ecosystem process, structure and function. By understanding what these benefits are, and how they impact the nearshore system crossings can be designed to provide maximum benefits more efficiently.

There is a dearth of information regarding the ecological impacts of constructing bridges or culverts across tidally influenced areas in the scientific literature. While hydrological and hydraulic impacts, such as amount and extent of anticipated scouring and longshore transport of sediment, are carefully considered during crossing design, impacts to overall geomorphology and ecological function are not. This may be because many decisions establishing culvert or bridge crossing design practice were made prior to 1969, before the passage of federal and state statutes that require inclusion of environmental impacts. Almost all tidal channel crossings were, and sometimes still are, designed to simply optimize hydraulic conveyance for drainage or design floods at least cost.

The loss of connectivity that occurs when dikes are constructed across wetlands and floodplains is well documented. Embanked bridge crossings can generate similar environmental impacts because they too may restrict the flow of animals, water, sediment, organic plant material and detritus. Today, however, there is an opportunity to assess and rectify the impacts of existing structures through restoration. The question that will need to be addressed is:

> *'what are the tradeoffs between enhanced ecologic benefits and restoration costs for breaches or bridges larger than those required for hydraulic conveyance?'*

The hierarchy of benefits represents a new approach to crossing design by expanding its view from the minimum opening size that the hydraulics requires to one that considers how location and size of openings will impact the morphology and ecology of the ecosystem. This hierarchy of benefits will aid PSNERP decision makers by shedding light on whether a dike removal or a dike modification, and associated construction and monitoring costs, is warranted given particular parameters. It is a tool devised for this specific project, and its development

was constrained by existing information and a short time horizon. It can be considered a starting place for cost-benefit analyses that incorporate the geomorphic and ecological aspects of ecosystem function.

2. CONCEPTUAL MODELS OF OPENINGS

PSNERP has described 21 management measures that that can be used to develop and evaluate Puget Sound nearshore restoration alternatives at individual sites. Management Measure 3 (MM3) (Clancy et al. 2009), describes in detail the need for and expected outcomes of dike removal or modification. One expected outcome is higher growth and survival of juvenile salmon in nearshore habitats. The connection between the restoration action (reintroducing the full tidal prism, flooding frequency and duration) and the goal (higher juvenile salmon survival rates) is expressed in a conceptual model that shows how the restoration action will likely restore processes and create structural changes that make the goal possible (see Figure 1).

Similarly, Management Measure 9 (MM9) (PSNERP 2009) describes the need for and expected outcomes of hydraulic modification. MM9 has comparable expected outcomes, and its conceptual model expresses how the restoration action (replace tide gate with open breach) will likely restore processes and create structural changes to improve salmon production and enhance other nearshore functions (see Figure 2).

Both dike removal or modification and hydraulic modification will result in a different type of opening across a tidally influenced area, such as a marsh or delta, than the constricted openings that currently exist. The impacts of the width, location and size of the new opening needs to be considered not only on the tidal and fluvial hydrology, but also on the geomorphic and ecologic processes of the tidally influenced area. This adds an additional dimension to the conceptual model because the rate at which the restoration goals can be achieved will be impacted by breach size.

3. IMPACTS OF CROSSING SIZE ON BARRIER ESTUARIES

Ecologic functioning of a number of barrier estuaries in the Puget Sound is constrained by road crossings. Typically, a road embankment has been constructed that follows the alignment of the natural barrier beach (Figure 3). The connection to tidal waters is often restricted to a single culvert or constricted bridge crossing. In addition, the inlet is fixed in location and high tide storm surge flows across the barrier beach are prevented by the embankment acting as a dike, reducing general flow over the marsh surface toward the bay front and eliminating wave action in the interior of the estuary.

The potential impacts of crossings on barrier estuaries are listed in Table 1 in terms of hydraulic and sedimentary processes and geomorphic and water quality impacts. The size of the inlet is often limited, which may partially or completely block the flow of water and mute the tide. This has implications for the location of head of tide and tidal prism volume. Small inlets may partially or completely block detritus, and large woody debris, and organic plant material from entering the estuary. Intertidal habitats inside the causeway may aggrade at a higher rate than areas outside due to the capture of sediment conveyed by floods from the watershed, or degrade when isolated from deposition of estuarine sediments brought in on the flood tide making these marshes more susceptible to the effects of sea level rise and geologic subsidence.

However these impacts do not occur in isolation. For example, within a barrier estuary alteration of the tidal signal has multiple hydrodynamic and geomorphic impacts including lowering of high tide elevations, raising low tide elevations, raising mean tide elevations, reducing the tidal frame, reducing the tidal prism in the marsh and reducing the tidal excursion. The structural and functional responses include isolation of marsh plains and conversion to fresher water habitats, a reduction in area of intertidal mudflat and sandflat habitat, siltation of tidal channels, an elevated water table affecting marsh to forest transition, a limited fluctuating water table affecting

plant growth, atrophy of the channel system due to sedimentation and reduced channel connectivity, and passive advective transport of organisms into the estuary through baroclinic circulation.

The combination of embankment and reduced inlet size reduce both the area of habitat and habitat connectivity which in turn impacts all aspects of ecosystem function: distribution and abundance of species, community dynamics, productivity, and invasive species.

In restoring the ecosystem functions of these estuaries, the main tool is to decrease the hydraulic constriction due to the crossing and increase the habitat connectivity. The size of the opening will determine the type and amount of ecosystem processes that are impacted. The largest possible opening size will eliminate these impacts, while a small opening size will likely produce all of them. Intermediately sized openings will have impacts between these two endpoints.

3.1 Benefits of Increasing Bridge Crossing Size

To illustrate how much ecological benefits increase as opening size increases, we have carried out a first-cut qualitative assessment of five general categories of crossings as described below (see Figure 5):

1. Existing conditions. This assumes a raised embankment along the barrier beach and tidal flow restricted to a single culvert or narrow bridge crossing sized to drain the area landward of the barrier. Tidal regime will be strongly muted. All flows over the barrier beach will be blocked by the embankment.

2. Expand the inlet size with large culverts or bridge crossing to allow regular tidal inundation of the area landward of the barrier. The inlet crossing is designed to be the minimum size to allow the full average diurnal tidal range within the estuary based on the hydraulic geometry for tidal channels. However, tidal velocities will be greater than naturally occurring at the inlet requiring armoring to prevent scour and lateral migration. In addition storm surge tides will still be constricted. All flows over the barrier beach will be blocked by the embankment.

3. Expand the inlet size to allow for a naturally adjusting channel inlet to form. This would require a clear span bridge designed wide enough to allow a natural convex sided inlet channel that can adjust to storm surge tides. All flows over the barrier beach are blocked by the embankment.

4. Expand the inlet crossing to allow for lateral migration of the inlet channel. A bridge would be sized not only for the appropriate inlet channel morphology but also for historic migration width. Laterally meandering inlets have a tendency to 'reset' the estuarine drainage system and marsh habitats through bank erosion and migrating flood tide shoals All flows over the barrier beach are blocked by the embankment.

5. Complete removal of tidal barriers. This would include a bridge crossing to allow inlet migration and replacement of the embankment with an elevated causeway on pilings. The former road embankment would be graded down to natural beach crest elevations to allow for storm surge inundation and transport of large woody debris (LWD) into the estuary. The input of LWD creates habitat structure for all trophic levels from algae to invertebrates to fishes and wildlife; it allows for various species to seek shelter, find food, spawn, roost or nest. LWD also impacts sediment movement, potentially creating beach berms. More recently, LWD has been cited in facilitating tidal marsh succession acts by providing a nursery habitat for salt-intolerant species (Maser and Sedell).

Table 1 shows in detail how various process alterations impact ecosystem structure and function. Figures 5 uses this information to qualitatively assign values to restored processes according to opening size.

4. IMPACTS OF CROSSING SIZE AND LOCATION ON RIVER DELTAS

River deltas are dynamic geomorphic landscapes, with river distributary channels that evolve and migrate in response to major floods. They sustain a gradient of wetland habitat types from forested floodplains to forested tidal wetland to tidal marsh and mudflat. Roadways traverse river deltas at many locations in Puget Sound (Figure 4). Typically these have been constructed for convenience on embankments on the flat intertidal areas across the delta front and have concentrated river flows at a single bridge crossing location. Fixing the river channel in this way can significantly reduce the area of active delta. Upstream the river is restrained from avulsing into different distributary channels, resulting in a reduced variety of habitat types, and because of increased sediment deposition, the floodplain and former intertidal habitats aggrade. Downstream, single bridge crossings may partially or completely block the flow of sediment that sustains marsh habitats. Channelizing the outflow of riverine sediment along a single alignment forces delta progradation, changes salinity distribution and causes impacts to natural systems.

For instance, the size and location of bridge crossings are factors that will ultimately determine the viability of a salmon population. A population will become more viable if the size and location of the new opening adds new habitat, connects habitat and increases habitat capacity. New tidal or distributary channels will help to increase all three of these criteria, which alter the distribution and composition of life history strategies and result in an increase in viability.

4.1 Benefits of Increasing Bridge Crossing Size

To illustrate how ecologic benefits of river delta habits could be restored with increasing the size of bridge crossings we have conducted a first cut qualitative assessment of the four alternatives described below (see Figure 6):

1. Existing conditions. Assumes the roadway has been constructed on an elevated embankment that prevents tidal and river flows, and the bridge crossing itself has been sized to the typical design flood. Channel avulsions and distributary channel formation are restricted to the area downstream of the crossing. Elsewhere downstream of the embankment, tidal marshes are not replenished by sedimentation and relict distributary channels silt in. Upstream former intertidal wetlands convert to floodplains and the river channel is prevented from migrating or avulsing with river training structures that simplify habitat structure within the river channel.

2. Additional bridge crossing. The existing bridge crossing is duplicated at a location where a major distributary channel had been blocked off by the embankment. This would encourage a channel avulsion upstream and permit the main river to switch its course between two crossings, doubling the size of the active delta.

3. Extended bridge crossings allow for channel migration. Bridge spans are widened to allow for historic rates of lateral channel migration. Laterally meandering channels 'reset' the fluvial system through bank erosion and subsequent deposition in point bars. This introduces sediment and LWD into channels from stream banks, and promotes the exchange of nutrient-rich soils into the fluvial system. The erosion of banks, and subsequent deposition, results in a dynamic system with a mosaic of habitat types.

4. Extended bridge crossings with road on pilings. This would allow for restoring complete tidal exehange across the delta front. In addition it would allow removal of upstream river embankments allowing for restoration of fluvial processes acting across the delta.

Table 2 shows in detail how various process alterations impact ecosystem structure and function. Figures 6 uses this information to qualitatively assign values to restored processes according to opening size.

4.2 Benefits of Changing Bridge Crossing Location

The amount of ecological benefits derived from restoration efforts is not only influenced by the size of the opening, but also by its location within a watershed. The location of a crossing will be impacted by the tides (Figure 7). A qualitative assessment of tidal effects can be accomplished by expanding upon an approach published in Hydraulic Engineering Circular (Richardson, 2001) that is used to evaluate hydrological processes at crossings. This is, in large part, a measure of the distance from the head of tide to the crossing location. As the distance increases, the volume of tidal prism increases and, in turn, the discharge associated with each tidal cycle. Discharge drives the transport of fluvial and marine sediment in the estuary and scour at crossings. The distance from head of tide is also a measure of the crossing's effect on estuarine processes. Estuarine development (fill, dikes, land use) modifies the level of impact.

Qualitative categories of impact include (see Figure 7):

1. Low impact– the crossing is located near to the head of tide where tidal inundation occurs within the main channel banks, or where the tidally inundated marsh area is small.

2. Medium impact – this category encompasses most of the cases where the road embankment is built in the middle of the delta.

3. High impact– the crossing is located at the marine edge of a marsh, or encloses a large area principally below mean high water. These are cases where tidal volume is large and that significant inundated areas are funneled through a single opening, cutting off flow into distributary channels and over the marsh edge.

5. REFERENCES

Maser, C. and Sedell, J.R., 1994. From the Forest to the Sea: the Ecology of Wood in Streams, Rivers, Estuaries, and Oceans. St. Lucie Press, Delray Beach, FL, 200 pp.

Clancy et al., 2009. Management Measures for Protecting and Restoring the Puget Sound Nearshore. Technical Report 2009-01.

Richardson, 2001. Hydraulic Engineering Circular.

Table 1. POTENTIAL ADVERSE IMPACTS OF CROSSINGS ON BARRIER ESTUARIES

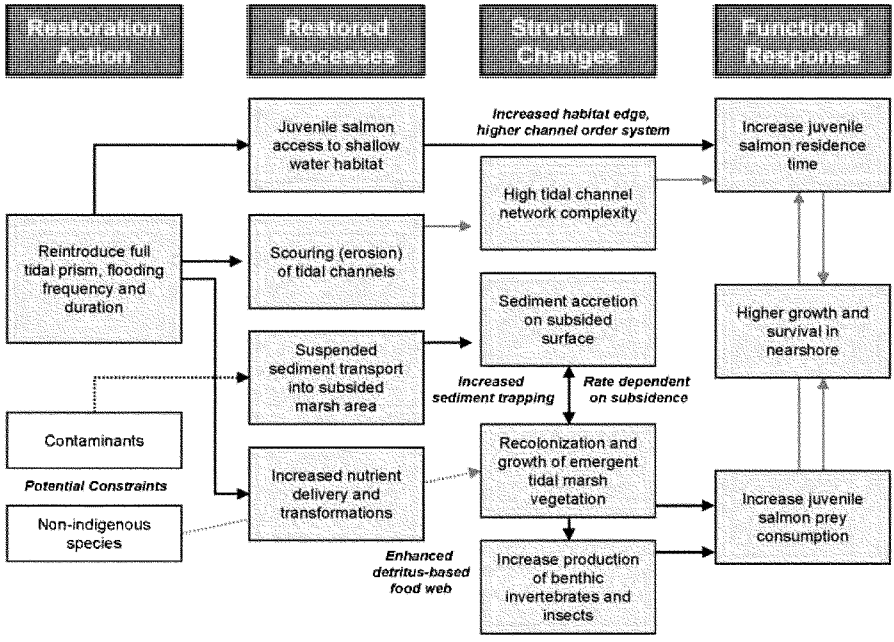
BARRIER ESTUARIES - Assumes culverted entrance, road embankment along beach alignment, watershed relatively small relative to estuary.

BARRIER ESTUARIES	Process	Structural Impact	Functional Response
HYDRAULIC/ HYDRODYNAMIC PROCESS IMPACTS	Alteration of tidal stage characteristics **(#2)**	Lowering of high tide elevations	Isolation of marsh plains, conversion to fresher habitats
		Raising low tide elevations	Reduction in area of intertidal mudflat/sandflat habitat
		Raising mean tide elevations	Water table elevated affecting marsh to forest transition
		Reduction in tidal frame	Water table fluctuation limited affecting plant growth
		Reduction in tidal prism in marsh	Channel system atrophies through sedimentation; reduced channel connectivity
		Reduced tidal excursion	Passive advective transport of organisms in and out of estuary diminished
	Alteration of salinity distribution **(#5)**	Vertical salinity stratification degraded through mixing	Reduction of passive transport of organisms into estuary through baroclinic circulation
		Salinity mixing zone length truncated	'Squeezing'and reduction of brackish zone habitats
	Elimination of storm surge overwash across beach **(#3, 4)**	Transport of large woody debris into marsh	Habitat heterogeneity reduced
		Mobilization of detritus due to storm surge wave action eliminated	Export of nutrients to estuary reduced
SEDIMENTARY PROCESS IMPACTS	Alluvial sedimentation altered by backwater affects	Fine sediment accumulates on marsh plain	Shift to upland habitats
		Coarse sediment accumulates in tidal channels	Loss of blind channel habitat
	Estuarine sedimentation limited by reduction in tidal flows **(#1)**	Reduced tidal prism reduces sediment delivery to marsh plain, causes lowering relative to tidal frame	Reduced productivity of marsh vegetation
		Increased turbidity in tidal channels due to loss of marsh plain sediment sink	Adverse affect on benthic organisms and eelgrass
GEOMORPHIC IMPACTS	Alteration of entrance channel morphology from broad shallow to narrow	Increased tidal velocity through entrance creates scour holes	Increased fish mortality
		Channel location fixed instead of lateral migration affecting ebb and flood shoal extent	Adverse affect on benthic organisms
		Fixed channel location may lead to permanent closure of confined marsh by longshore drift	Eliminates exchange of water, sediment, nutrients and organisms
	Atrophied tidal drainage system	Tidal channels shallower	Degraded estuarine habitat
		Dendritic tidal channel system becomes disconnected	Estuarine habitat degraded
	Marsh plain elevations changed	Lowered marsh plain	Reduced marsh productivity
		Areas raised by alluvial sedimentation	Change to freshwater or upland species
WATER QUALITY IMPACTS	Increased residence time **(#6)**	Reduction in tidal exchange	Algal blooms in marsh channels, anoxic in poorly drained holes
		Reduction in tidal excursion	Export of water column productivity to larger estuary limited
	Accumulation of toxics	Reduced tidal scouring allows accumulation of polluted sediments from watershed	Toxic affects on organisms
		Reduced residence time means concentration of dissolved pollutants in water column is higher	Toxic affects on organisms

Table 2. POTENTIAL ADVERSE IMPACTS OF CROSSINGS ON RIVER DELTAS

RIVER DELTAS - Assumes single bridge crossing across main river sized for major river flood on piers, road embankment across rest of delta.

RIVER DELTAS			
HYDRAULIC/ HYDRODYNAMIC PROCESS IMPACTS	Alteration of fluvial flows	Concentration of flood flows at one discharge point raises flood stages upstream	Shift from marshplain to floodplain ecologic processes
		Elimination of out of bank flows upstream increases discharge, scouring and flood velocities in main channel	Reduction of fish refuge habitat and shallow water habitat
	Alteration of estuarine tidal flows	Deeper main channel can extend tidal influence further upstream	Introduction of predators upstream
	Alteration of estuarine salinity distribution	Extension of single channel into deeper waters creates abrupt fresh to salt water mixing zone	Adverse impacts on anadramous migration
		Elimination of distributary channels alters spatial distribution of mixing zones across delta front.	Reduction in brackish zone, adverse impact on shellfish
		Elimination of distributary channels reduces linear extent of salinity transition zones	Reduction in anadramous fish habitat
SEDIMENTARY PROCESS IMPACTS	Alluvial sedimentation	Increased sedimentation on marshplain/floodplain upstream	Conversion from tidal marsh to floodplain habitats
		Reduced sediment delivery and erosion where distributary channels have been blocked	Loss of intertidal habitats
		Coarse sedimentation concentrated at mouth of single channel, instead of being distributed along multiple channels across delta front	Loss of habitat heterogeneity
	Estuarine sedimentation	Estuarine mudflats not replenished during flood events –fine alluvial sediments lost to deep water	Loss of intertidal mudflat/sandflat habitat
		Reduced flood tide suspended sediment concentrations reduce marshplain sedimentation rates	Loss of productivity and area of marshplain habitat
	Large wood accumulation	More export of large woody debris	Reduction in complexity of channel habitat
GEOMORPHIC IMPACTS	Spatial reduction of active delta	Reduction in area	Loss of benefits of large scale ecologic processes
		Simplification of deltaic system	Reduction in heterogeneity of habitats, loss of alteruate migratory routes
		Disruption of natural gradient of wetland habits from floodplain to mudflat	Loss of connectivity of habitats, fragmentation of habitats
		Delinking of river channel from marshes	Adverse affect on migrating fish
	Main river channel changes	Deeper river channel	Simplification of fish habitat
		Channel location fixed	Reduction in habitat complexity derived from meandering processes
		Extension of delta lobe to deeper water reducing channel slope, increasing in-channel sediment deposition	Loss of watershed derived nutrients to estuarine system
	Distributary channel changes	Remnant distributary channel atrophies	Loss of channel edge habitat and migration routes
	Marshplain system changes	Marshplain erosion	Loss of marsh area, conversion to mud/sand flat
		Marshplain lowering	Reduction of productivity
	Mudflat changes	Mudflat lowering	Loss of mudflat habitat



Source: PSNERP Management Measures (2009)

figure 1
PSNERP Concept Engineering

Conceptual model of dike removal or modification

PWA Ref# 2036.01

PWA

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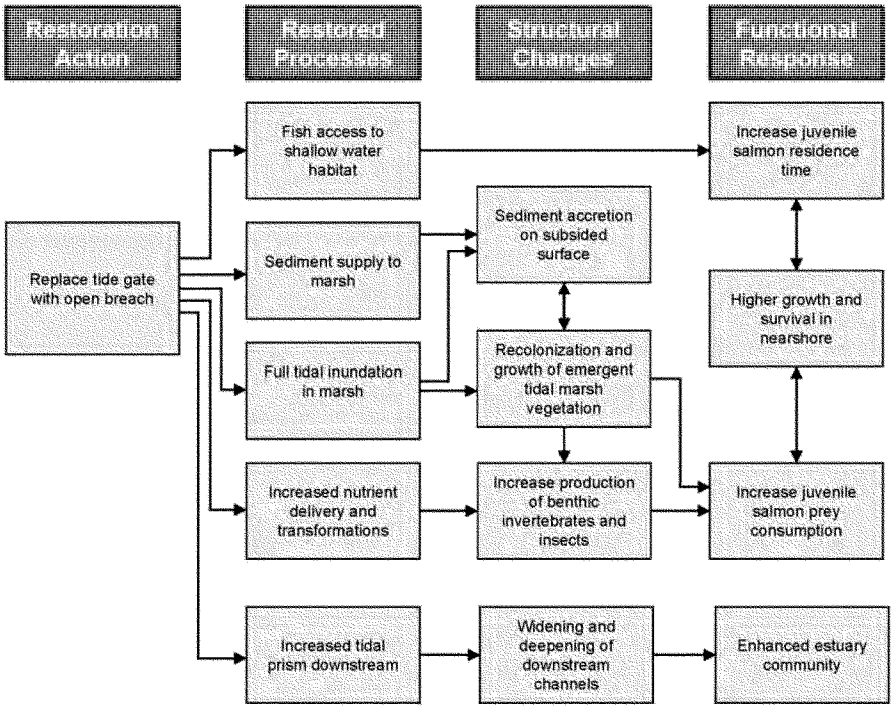

Source: PSNERP Management Measures (2009)

figure 2
PSNERP Concept Engineering

Conceptual model of hydraulic modification

PWA Ref# 2036.01

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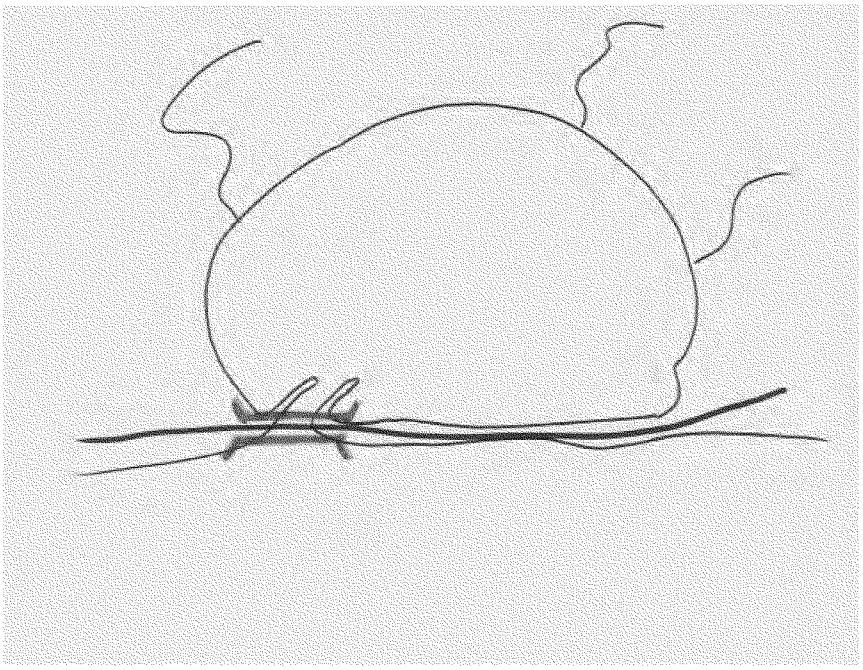
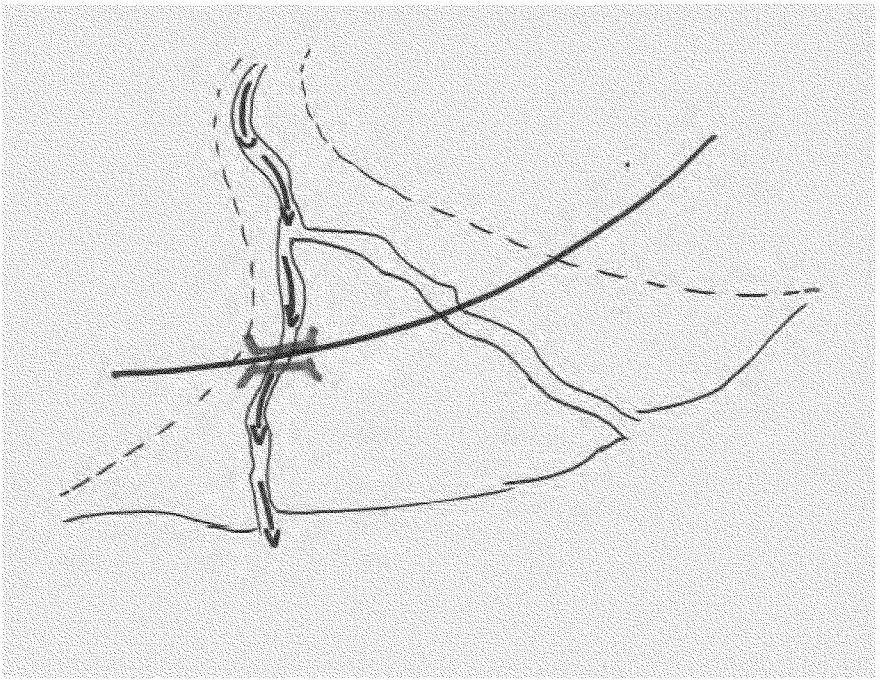


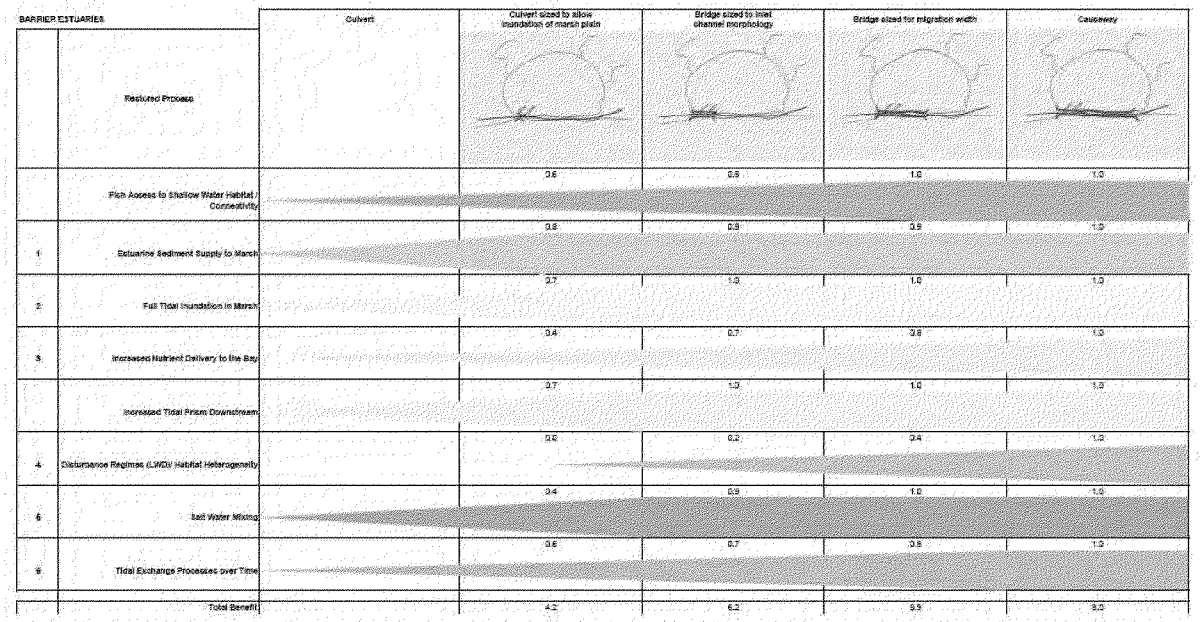
Source:	*figure* **3** *PSNERP Concept Engineering*
	General layout of barrier estuary crossing
	PWA Ref# 2036.01 PWA

\\Mars\Projects\2036.01_PSNERP_Phase_1_Conceptual_Engineering\Applied Geomorphology Guidelines\Hierarchy of Openings\Fig 3 General layout of barrier estuary.doc



Source:	*figure* **3** *PSNERP Concept Engineering*
	General layout of river delta crossing
	PWA Ref# 2036.01 PWA

\\Mars\Projects\2036.01_PSNERP_Phase_1_Conceptual_Engineering\Applied Geomorphology Guidelines\Hierarchy of Openings\Fig 4 General layout of river delta.doc



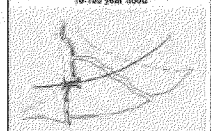
Source:

figure **5**
PSNERP Concept Engineering

Benefits of widening crossings of a barrier estuary

PWA Ref# 2036.01

PWA

Restored Process	Culvert not feasible	Bridge sized to 10-100 year flood	Two Bridges	Two Bridges sized for migration width	Two Bridges and Causeway
					
Fish Access to Shallow Water Habitat / Connectivity		0.1	0.4	0.8	0.8
Estuarine Sediment Supply to Marsh		0.1	0.3	0.6	1.0
Distributary Channel Formation		0.1	0.4	0.8	0.8
Increased Nutrient Delivery to the Bay		0.2	0.4	0.4	0.4
Channel Migration		0.0 0.0	0.1	0.4	0.8
Salt Water Mixing		0.2	0.8	0.8	0.8
	Total Benefit	0.7	2.2	3.8	4.2

Source:

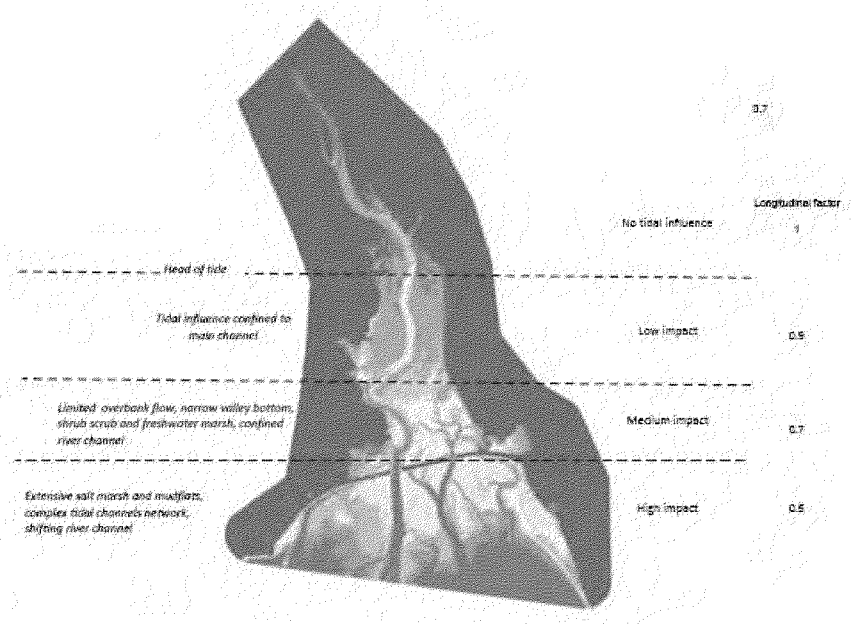
figure **6**
PSNERP Concept Engineering

Benefits of widening crossings of a river delta

PWA Ref# 2036.01

PWA

\\Mars\Projects\2036.01_PSNERP_Phase_1_Conceptual_Engineering\Applied Geomorphology Guidelines\Hierarchy of Openings\Fig 6 Benefits for a river delta.doc



Source:

figure 7
PSNERP Concept Engineering

Location of crossing

PWA Ref# 2036.01

PWA

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

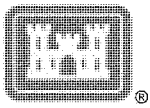
APPENDIX C

REAL ESTATE PLAN

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps
of Engineers®
Seattle District



U.S. ARMY CORPS OF ENGINEERS BUILDING STRONG®

REAL ESTATE PLAN

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

Real Estate Division Seattle District
U.S. Army Corps of Engineers

January 2016

Project Partners:
U.S. Army Corps of Engineers
Washington Department of Fish and Wildlife

U.S. ARMY CORPS OF ENGINEERS – SEATTLE DISTRICT
4735 EAST MARGINAL WAY SOUTH, SEATTLE WA 98134-2385
WWW.NWS.USACE.ARMY.MIL

REAL ESTATE PLAN
PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

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Exhibit A: Project Overview Map
Exhibit B: Real Estate Maps *(Specific Project Sites)*
Exhibit C: Approval to Waive Appraisal Requirements for Puget Sound Nearshore Ecosystem Restoration Project, dtd 10 Jul 2012
Exhibit D: Capability Assessment of Non-Federal Sponsor
Exhibit E: Draft Certification of Lands and Authorization for Entry, Attorney's Certificate and Third Party Risk Analysis
Exhibit F: Real Estate Policy Guidance Letter No. 31, Real Estate Support to Civil Works Planning Paradigm (3x3x3)

REAL ESTATE PLAN

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)

THIS REAL ESTATE PLAN (REP) IS CONSISTENT WITH THE LEVEL OF DETAIL CONTAINED IN THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP) FEASIBILITY/ENVIRONMENTAL IMPACT STATEMENT. THIS REP WAS DEVELOPED UTILIZING LIMITED INFORMATION AVAILABLE DURING THE FEASIBILITY STUDY PHASE OF THE PROJECT. IT WILL BE UPDATED TO FULLY COMPLY WITH ER 405-1-12 DURING THE PRE-CONSTRUCTION ENGINEERING AND DESIGN (PED) PHASE.

1.0 INTRODUCTION

1.1 Real Estate Plan Purpose

This Real Estate Plan (REP) is presented in support of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). The project is authorized under Section 209 of the River and Harbor Act of 1962 (P.L. 84-874) and was initiated as a USACE Civil, Title 1 general investigation study under Public Law 106-60 (29 September 1999). The purpose of the REP is typically to identify lands, easements, rights-of-way, relocations and disposal sites (LERRD) necessary to support construction, operation and maintenance of the proposed project. However, due to the limited design information available at this time, this plan seeks to provide information on any real estate activities that may be involved for the identified project based on current information available.

The REP is tentative in nature; it is for planning purposes only and both the final real property acquisition lines and real estate cost estimates provided are subject to change based on the final project design.

The Non-Federal Sponsor (NFS) for this project is the Washington Department of Fish and Wildlife (WDFW).

1.2 General Project Background and Description

As of 2014, 13 fish and marine mammal species in Puget Sound are listed as threatened or endangered or identified as candidate species under the ESA. Within the Study area, there are three listed endangered species and 10 threatened species. Recovery plans for eight of the ESA-listed species have been or are being developed by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish

and Wildlife Service. Actions proposed by the Nearshore Study support salmon recovery consistent with NOAA's salmon recovery plans.

All sites of the recommended plan include critical habitat for Endangered Species Act (ESA) listed species. The study area is located within the nearshore zone of the Puget Sound Basin located in the northwest Washington, and consists primarily of rural residential and agricultural zoning. The project is comprised of the Duckabush River Estuary, Nooksack River Delta and North Fork Skagit River Delta sites *(See Exhibit A for an overview of the site locations).* The total project cost, based on the 2016 Cost Estimate is $452,286,000; Total cost for Lands, Improvements and Damages is $20,451,365, or 5% of the total project cost.

1.2.1 Duckabush River Estuary: The Duckabush River is located in Jefferson County and is one of several major river systems in the Hood Canal Subbasin draining the east slope of the Olympic Mountains to Hood Canal. The broad Duckabush River delta fans out into Hood Canal where Highway 101 causeway crosses the estuary, spanning the main channel and a northern distributary channel via bridges. The area south of the river delta is primarily a basaltic shoreline with a few pocket beaches. Residential development is concentrated primarily just south of the estuary.

The proposed action for the Duckabush River Estuary would restore the natural geomorphology to the Duckabush River delta wetlands by removing major roadway obstructions, excavating channels and removing fill. The restoration proposal would include the removal of the Highway 101 causeway and bridges across the estuary, allowing significant restoration of tidal exchange in the Duckabush River Estuary. An elevated roadway on a 2,100-foot-long bridge would be constructed in a new alignment further upstream from the existing highway, allowing for tidal exchange to occur and distributary channels to develop while maintaining the key transportation route on Highway 101. Berms along the river would be removed to restore channel migration and channels would be excavated at or near their historical configurations, which would reestablish tidal and freshwater connections throughout the estuary. *(See Exhibit B, 1.2.1 for Duckabush River Estuary map and site features.)*

1.2.2 Nooksack River Delta: This action area is in Whatcom County and is centered on the Lummi Reservation north of Bellingham in the San Juan/Georgia Strait Subbasin. It encompasses nearly all of the Nooksack and Lummi River deltas below Ferndale, Washington. The Nooksack River has progressively built its delta toward and around the Lummi Peninsula. The course of the main river has alternated to either side of the Lummi Peninsula, altering the balance of freshwater and sediment delivery.

The proposed action for the Nooksack River Delta would address levees, roads and other barriers to restore water and sediment processes throughout the historical Nooksack River delta. The restoration proposal includes actions on both the Nooksack River and Lummi River. Approximately 60% (12,000 linear feet) of the

Nooksack River's right and left bank dikes will be removed, allowing the river to be reconnected to historical tidal areas and floodplain habitats. A new setback levee will be constructed along the right bank of the Nooksack River to maintain existing levels of flood risk management in the area while still allowing reconnection of high value floodplain habitats. The setback levee will generally follow the existing Ferndale Road alignment, as the existing embankments are already raised and the road provides primary access to portions of the Lummi Indian Reservation.

There are no setback levees proposed for the left bank of the Nooksack River because the restored area is uninhabited north of Marine Drive and ties into high ground. In addition to the levee removals and setback levee construction on the Nooksack River, large woody debris structures will also be installed in the river to promote hydraulic stability and improve habitat complexity. On the downstream end of the project footprint, a flood-prone portion of the community of Marietta will be relocated to restore a small portion of the floodplain, avoid flooding impacts from the left bank levee removal, and avoid additional project costs assocsiated with providing flood risk management features to this relatively small area.

A new water control structure (i.e., diversion feature) will be installed at the confluence of the Lummi and Nooksack Rivers. This structure is intended to facilitate transfer of freshwater and sediment to the Lummi River, while preventing avulsion of the mainstem to the west. The Lummi River channel will be regraded to reconnect it to Nooksack River flows, allowing the Lummi River to better match invert to water surface elevation of the Nooksack River, increase conveyance capacity, and encourage normal geomorphic processes in the river.

On the Lummi River, approximately 12,000 linear feet of berm would be removed to regain all of the shoreline complexity and dynamic shoreline processes on the north bank in the vicinity of North Red River Road, west of Haxton Way. A new setback levee will be constructed along the north bank of the Lummi River to allow reconnection of high value floodplain habitats while maintain existing levels of flood risk management in the area. As described above, the setback levees are required to maintain social and tribal accpetability at the site.

Finally, the restoration proposal includes several road removals and/or relocations. Portions of existing roadways will be removed or raised to allow for floodplain restoration in the areas where levees are removed. Construction of new bridges or installation of culverts on both the Nooksack and Lummi Rivers will allow tidal exchange across the restored Nooksack River Delta *(See Exhibit B, 1.2.2 for Nooksack River Delta map and site features).*

1.2.3 North Fork Skagit River Delta: This action area is located in Skagit County along the lower reach of the North Fork of the Skagit River, south of LaConner. Extensive diking of the North Fork Skagit River has caused substantial loss of estuarine connectivity.

The restoration proposal includes actions on both the south and north banks of the North Fork Skagit River. Approximately 13,000 feet of levee along the south bank will be lowered to allow creation of a tidal channel network on the south side of the river. In addition to lowering levees, a new levee will be constructed along a road alignment (Rawlins Road) to promote riverine and tidal exchange in the project area, to isolate the restoration area from surrounding agriculture, and to maintain existing levels of flood risk management to surrounding land and infrastructure. This setback levee alignment follows the embankment for Rawlins Road and ties into the coastal dike system. On the north bank of the river, approximately 3,140 feet of shore armoring would also be lowered. Existing topography and an upland levee provide site boundaries and flood risk management without the need for a new levee on the river's north side; the northern boundary ties into high ground and the existing Diking District 9 levee. Planned breaches in the lowered levee and in the area of armor removal as well as excavated channels on both banks of the river will allow for water to access the newly restored floodplain. Replanting lowered levees will restore a natural riparian corridor along the river.

The current alternative also includes levee lowering and excavation of new tidal channels on the eastern portion of the project footprint. *(See Exhibit B, 1.2.3 for North Fork Skagit River Delta map and site features.)*

1.3 Previous Studies

There are no prior written real estate plans for this project.

2.0 Description of Lands, Easements, Rights-of-Ways, Relocations and Disposals (LERRD)

Based on the current feasibility level of design, the project features impact a combination of private, public and tribal lands totaling approximately 2,480 acres. An estimated 220 parcels will be affected either fully or partially by this project.

Due to the limited level of detail associated with the current project phase, all lands within the project footprint were valued as fee simple interests. Anticipated real estate interests have been identified in Section 4.0, however, the project is unable to identify specific estates with affected parcels at this phase of the project. A detailed evaluation of the appropriate real estate interests to be acquired will be determined during PED and will be refined and reflected within the updated REP. Full coordination will take place with the vertical team.

The tables below identify the parcels, acreages affected, and ownership type for each of the project sites. This information is tentative in nature and will be revised during PED. The values per parcel are not included in the table below – rather, for the purposes of this REP, the project site value is based on fee simple and is provided as a lump-sum amount in the BCERE Summary Table (See Section 11). The updated estimated value, affected acreages and associated real estate interests will be identified and included with the updated REP.

Duckabush River Estuary

Parcel ID	Project Acres	Ownership Type
502164001	0.09	Public
502164004	0.51	Private
502164010	1.36	Public
502164011	0.05	Private
502164012	7.37	Public
502164014	4.52	Private
502164039	0.20	Private
502164041	0.01	Private
502164049	0.55	Public
502164051	2.39	Public
502164052	4.72	Public
502164053	0.22	Private
502164055	4.10	Public
502211001	11.07	Public
502211002	5.91	Public
502211003	9.88	Public
502211004	2.85	Public
502211019	0.14	Private
980700522	0.04	Private
981002228	0.93	Private
981002229	0.26	Public
981002324	0.04	Private
981002325	0.03	Private
981301409	0.06	Private
981301410	0.06	Private

Parcel ID	Project Acres	Ownership Type
981301411	0.11	Private
981301412	0.27	Private
TOTAL ACRES *(rounded)*	58 acres *(Estimated Value: $252,365)*	----------

NOTE: *Although some residential parcels are affected, the current project footprint does not impact the actual structure. As a result PL 91-646 requirements are not currently associated with this site.*

Nooksack River Delta

Parcel ID	Project Acres	Ownership Type
380101067469	34.14	Private
380101999902	3.61	Tribal/Public/Private
380101999905	187.94	U.S. Dept of Interior/Tribal
380102066107	76.37	Private
380102395080	0.76	Private
380102999902	4.73	Tribal/Public/Private
380103999902	0.72	Tribal/Public/Private
380110070485	2.00	Private
380110080471	0.18	Private
380110086471	0.25	Private
380110092468	0.15	Private
380110999902	18.54	Tribal/Public/Private
380111999902	11.91	Tribal/Public/Private
380114999902	7.31	Tribal/Public/Private
380115999905	5.27	Tribal/Public/Private
380204020286	3.30	Public
380204080449	45.82	Public
380205016144	0.98	Private
380205050285	19.87	Private
380205052223	19.88	Private

Parcel ID	Project Acres	Ownership Type
380205061512	10.32	Private
380205066453	27.34	Private
380205117360	35.31	Private
380205121103	45.84	Private
380205140175	99.41	Private
380205218305	4.83	Private
380205235240	25.89	Private
380205246369	6.03	Private
380205251306	5.34	Private
380205254480	61.78	Private
380205391202	173.18	Public
380205445489	46.48	Public
380205495245	30.22	Public
380206125500	0.60	Private
380206472043	20.87	Private
380206999902	0.93	Tribal/Public/Private
380206999905	21.24	U.S. Dept. of Interior/Tribal
380207348051	55.25	Tribal
380207424149	23.04	Tribal
380207435426	14.76	Private
380207498032	27.46	Tribal
380207999902	1.46	U.S. Dept. of Interior/Tribal
380207999905	35.22	U.S. Dept. of Interior/Tribal
380208027211	6.07	Private
380208032099	5.16	Tribal
380208040177	1.23	Private
380208041166	1.29	Private
380208042146	1.36	Private

Parcel ID	Project Acres	Ownership Type
380208042156	1.31	Public
380208043138	1.37	Tribal
380208076102	6.18	Tribal
380208104054	0.17	Tribal
380208110431	82.94	Private
380208127524	14.58	Private
380208177039	0.91	Private
380208200113	3.43	Public
380208209018	12.22	Public
380208210211	171.59	Public
380208255420	78.48	Public
380208283015	0.82	Public
380208294092	10.77	Public
380208308225	10.42	Public
380208316019	1.91	Public
380208359085	15.76	Public
380208378003	1.60	Private
380208417366	8.74	Private
380217336550	1.96	Public
380217341533	0.19	Private
380217346544	0.05	Private
380217349531	0.12	Private
380217350523	0.06	Private
380217350526	0.14	Private
380217352521	0.08	Private
380217352559	0.30	Private
380217354518	0.14	Private
380217356549	0.19	Private

Parcel ID	Project Acres	Ownership Type
380217359511	0.14	Private
380217359543	0.07	Public
380217361515	0.19	Private
380217361542	0.13	Public
380217362560	0.19	Private
380217363536	0.07	Public
380217364499	0.07	Private
380217366555	0.20	Private
380217368526	0.51	Private
380217373485	0.11	Public
380217373491	0.07	Private
380217373545	0.28	Private
380217377507	0.08	Private
380217377510	0.13	Public
380217378524	0.42	Private
380217382475	0.18	Tribal
380217384498	0.13	Private
380217388520	0.13	Public
380217389493	0.33	Private
380217390461	0.03	Private
380217391488	0.10	Public
380217392516	0.08	Public
380217394457	0.02	Private
380217394482	0.16	Public
380217399452	0.05	Public
380217399479	0.11	Private
380217401497	0.07	Tribal
380217402493	0.14	Private

Parcel ID	Project Acres	Ownership Type
380217405464	0.18	Private
380217405489	0.07	Private
380217405527	0.20	Public
380217406446	0.05	Private
380217407483	0.13	Public
380217407486	0.06	Public
380217410460	0.06	Private
380217413439	0.04	Public
380217415457	0.19	Private
380217417435	0.03	Public
380217419432	0.02	Private
380217420452	0.13	Private
380217422468	0.50	Private
380217427444	0.15	Private
380217427448	0.29	Private
380217428461	0.16	Private
380217428473	0.37	Private
380217430423	0.07	Public
380217436415	0.07	Public
380217436452	0.17	Private
380217439435	0.09	Private
380217452435	0.61	Private
380217461450	5.64	Private
380217488384	0.96	Private
380217488408	5.20	Private
390231062054	37.47	Private
390231183033	22.50	Private
390231240211	38.44	Private

Parcel ID	Project Acres	Ownership Type
390231276082	12.14	Private
390231333060	25.99	Private
390231362322	1.34	Private
390231448194	40.92	Private
390232082203	38.26	Private
390232085068	13.58	Private
390232086116	14.05	Private
390232086140	0.74	Private
390232118298	20.23	Private
390232160124	5.59	Private
390232168205	12.01	Private
390232210015	26.07	Private
390232265136	45.55	Private
390232291054	34.49	Private
ln3801029999	0.41	U.S. Dept. of Interior/Tribal
TOTAL ACRES *(rounded)*	2,080 acres *(Estimated Value: $10,899,000)*	----------

NOTE: *The shaded parcels (36) signify residential improvements to the property, according to County Assessor records. As a result, PL 91-646 requirements are assumed (See Section 12).*

North Fork Skagit River

Parcel ID	Project Acres	Ownership Type
P15517	2.41	Private
P15523	2.81	Private
P15556	20.16	Private
P15575	0.22	Private
P15610	0.45	Private

Parcel ID	Project Acres	Ownership Type
P15614	7.26	Private
P15539	5.93	Private
P15519	0.98	Public
P15634	1.01	Public
P15636	1.40	Public
P15640	3.44	Public
P15661	23.15	Private
P15571	33.07	Private
P15551	20.10	Private
P15554	13.80	Private
P15555	7.17	Private
P15637	0.19	Private
P15643	3.44	Private
P15512	44.20	Private
P15515	2.55	Private
P15670	0.75	Private
P15514	35.05	Private
P15960	0.37	Private
P15918	0.003	Private
P15576	0.90	Private
P15920	0.04	Private
P15511	12.03	Private
P15531	2.28	Private
P15607	0.13	Private
P15952	0.46	Private
P15552	1.51	Private
P15927	0.22	Private
P15541	8.11	Private

Parcel ID	Project Acres	Ownership Type
P15540	0.00	Private
P15513	2.02	Private
P15559	28.0	Private
P15929	0.40	Private
P15639	0.85	Public
P15527	0.24	Public
P15570	5.88	Private
P15518	43.03	Private
P15953	0.12	Private
P15961	0.46	Private
P15520	1.30	U.S.A.
P15558	3.50	Private
TOTAL ACRES *(rounded)*	342 acres *(Estimated Value: $9,300,000)*	----------

NOTE: *The shaded parcels (21) signify residential improvements to the property, according to County Assessor records. As a result, PL 91-646 requirements are assumed (See Section 12).*

2.1 Access

Specific access points have not been identified for this phase of the project, but will be determined during the PED phase. For the purposes of the currently level of design, it is assumed that access will be from public right-of-way or NFS acquired lands/easements. Preliminary information indicates that in addition to access during the construction period, perpetual road easements may also be required for Operation and Maintenance once construction is complete. Any temporary access/perpetual road easements will also be identified/confirmed during PED.

2.2 Staging

Specific staging areas have not been identified for this phase of the project, but will be determined during the PED phase. Where possible, the staging areas will be located within the project footprint. The NFS will be required, at a minimum, to acquire a standard Temporary Work Area Easement to address staging areas.

2.3 Borrow

Sources for borrow material have not been identified for this phase of the project, but will be identified when subsurface explorations are conducted during PED. Every effort will be made to secure enough borrow material from the study footprint excavations.

However, if not enough material is available, it is anticipated that borrow/temporary work area easements will be secured, as appropriate.

2.4 Disposal

Suitable excavated materials are intended to be re-utilized within the proposed project footprint as much as feasible. Any material unsuitable for re-use will be disposed of at a commercial disposal site to be identified during PED.

3.0 Non-Federal Sponsor Owned LERRD

Of the approximate 2,480 acres of land currently estimated for the project, the NFS currently owns approximately 640 acres in fee. These land are available for the project, but not sufficient to cover all improvements. As a result, the NFS will be required to acquire additional lands/estates for the project prior to construction, however, they have been advised of the risk of acquiring additional lands prior to signing the Project Partnership Agreement (PPA) *(Risk Letter dated August 23, 2013).* Due to the preliminary nature of the project, LERRD credit eligibility for NFS-owned lands will be determined during the PED phase. Any NFS land owned more than five years prior to the date of the PPA will not be eligible for incidental administrative LERRD crediting, as per ER 405-1-12, Chapter 12, paragraph 12-36.

4.0 Estates

Due to the current level of design and limited hydrology data, definitive estates have not been identified or assigned to individual parcels, however, at a minimum, the following standard estates are *anticipated* to be utilized for land acquisition purposes upon completion of the design developed during the PED phase.

Fee – The fee simple title to the land described in Exhibit ____/Section _____, Subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines. *(For those parcels/areas identified for ecosystem restoration purposes only which cannot be acquired under an easement).*

Perpetual Road Easement -- A perpetual exclusive easement and right-of-way in, on, over and across the land described in Exhibit A for the location, construction, operation, maintenance, alteration, replacement of roads and appurtenances thereto; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Exhibit A subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines. *(For Operation and Maintenance access to restoration features, if not accessible from public roadways or fee-owned property by NFS).*

Temporary Work Area Easement -- A temporary easement and right-of-way in, on, over and across the land described in Exhibit A for a period not to exceed _____(___) years, beginning with date of possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a work area,

including the right to borrow and/or deposit fill, spoil and waste material thereon, move store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines. *(For staging or other temporary work areas).*

Perpetual Channel Improvement Easement -- A perpetual and assignable right and easement to construct, operate, and maintain channel improvement works on, over, and across (the land described in Schedule A) (Tracts Nos. ____, _____, and _____) for the purposes as authorized by the Act of Congress approved _____, including the right to clear, cut, fell, remove, and dispose of any and all timber, trees, underbrush, buildings, improvements, and/or other obstructions therefrom; to excavate, dredge, cut away, and remove any or all of said land and to place thereon dredge or spoil material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads, and pipelines. *(For any potential Channel Improvement Easements where fee may not be applicable).*

Perpetual Flowage Easement *(Occasional Flooding)* – The perpetual right, power, privilege and easement occasionally to overflow, flood and submerge the land described in Exhibit A in connection with the operation and maintenance of the project as authorized by the Act of Congress approved _____, together with all right, title and interest in and to the structure; and improvements now situated on the land, except fencing (and also excepting _____ (here identify those structures not designed for human habitation which the District Engineer determines may remain on the land)); provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the United States in charge of the project, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and or placement of landfill; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; provided further that any use of the land shall be subject to Federal and State laws with respect to pollution. *(For any possible occasional induced flooding outside of project footprint caused by project that may be identified during PED phase where fee may not be applicable).*

5.0 Non-Standard Estates

Due to the current limited level of design, it is unknown if any Non-Standard Estates will be required for this project. As design and project footprint maps are further defined, any Non-Standard Estate(s) will be composed and submitted to HQ for approval as early as possible to ensure the justification is sound and will serve the project purpose.

6.0 Existing Federal Projects Within the LERRD Required for the Project

No known existing Federal projects are located within the LERRD required for the project footprint.

7.0 Federally-Owned Lands within the LERRD

7a. Duckabush River Estuary: There are no federally owned lands included within the LERRD required for the project.

7b. Nooksack River Delta: Based on the Cost Estimate developed for Nooksack, the U.S. Department of Interior/Tribal owns approximately 246 acres within the project footprint. The Lummi Tribe continues to be supportive of the project, paving the way for WDFW to obtain easements on affected tribal lands. Another possible option is to have the Lummi Tribe sign the PPA for the sole purpose of providing project lands at the Nooksack site.

7c. North Fork Skagit River Delta: Based on the Cost Estimate developed for North Fork, USA owns 1.3 acres within the project footprint. The acreage owned by the USA is designated as a water area and appears to be public hunting and/or fishing access. There has been no discussion with the agency regarding this project, to date. The affected parcel is on the fringe of the project footprint – it is anticipated that during PED, the final design will tighten up the project footprint, eliminating the need for this acreage.

8.0 Navigational Servitude

The navigation servitude is the dominant right of the Government under the commerce Clause of the U.S. Constitution to use, control and regulate the navigable waters of the United States and submerged lands thereunder.

The Puget Sound Nearshore study area consists of the nearshore zone, which includes beaches and the adjacent tops of coastal banks of bluffs, the shallow waters in estuarine deltas, and the tidal water from the head of tide to a depth of approximately 10 m relative to the mean lower low water (MLLW). The project features study area does not serve in aid of commerce, as defined in ER 405-1-12 (paragraph 17-7c). Based on the MLLW determination, coupled with research performed by USACE Seattle District Regulatory Navigation Section, Federal Navigational Servitude is not applicable to, and will not be invoked for this project site.

9.0 Real Estate Maps

A set of maps that depict the project area as it is currently known, and the affected tracts are included in Exhibit B. A more detailed real estate map depicting the final project footprint to include definitive real estate interests required, location of utilities/facilities, as applicable, and lands required for Operation and Maintenance (O&M) will be developed during PED.

10.0 Induced Flooding

For the purposes of the PSNERP Feasibility Report, and due to the limited design and hydrology data currently available, the study team assumed there is no induced flooding outside of the project footprint as shown in Exhibit B. As a result, no Physical Takings Analysis was performed. Induced flooding determination will be further addressed during the PED phase based on additional project design and hydrology data. For more information, please see the Hydrology Appendix to the main report.

11.0 Baseline Cost Estimate for Real Estate (BCERE)

Land Cost Estimates for LERRD values, rather than Gross Appraisals were utilized as the basis of the USACE Civil Cost Share Program real estate planning support for this project. This approach was authorized via an exception to policy waiver, dated 10 July 2012 by Scott Whiteford, USACE Director of Real Estate (see Exhibit C). The Land Cost Estimate approach also conforms with Policy Letter No. 31, which was published January 10, 2013.

The Land Cost Estimates for the current 3 project sites have been performed as the sites have been identified as part of the Tentatively Selected Plan (TSP). Consequently, the Land Cost Estimate reports were developed during different years and range from 2012 to 2015. Based on the location of the sites (outlying, urban areas) and land use (agricultural, wetlands), market values are assumed to have remained stable with marginal growth, if any. Due to the limited design, basic project footprint and the initial land cost analysis for this phase of the project *(land values are estimated to be 5% of total project costs)*, along with funding limitations, the land cost estimates were not revised to 2015 levels, as the results were anticipated to be negligible. Land value estimates will be updated/refined during PED to reflect the final design and updated project land values.

BCERE SUMMARY TABLE

Project Cost Factors	Duckabush River Estuary	Nooksack River Delta	North Fork Skagit River Delta
Project Footprint Acreage/ Number of Parcels Affected	58 acres 26 parcels	2,080 acres 147 parcels	342 acres 45 parcels
Land Values per Assessor *(fee value + contingency)*	$252,365	$10,899,000	$9,300,000
PL 91-646 Relocation Costs *(w/contingency – See Sec 12.0)*	$0.00	$3,802,260	$4,047,340
Utility/Facility Relocation Costs*(w/contingency-Sec 17.2)*	$47,561,000	$82,939,000	$0
NFS Admin Costs *(based on $8K/parcel; $10K/parcel involving relocations + 10% contingency)*	$228,800	$976,800	$211,200
		$396,000	$231,000
Federal Admin Costs *(based on $2,500/parcel; $3K/parcel involving relocations+ 10% contingency)*	$71,500	$305,250	$66,000
		$118,800	$69,300
Total LERRD Estimated Costs/Site	**$48,113,665**	**$99,437,110**	**$13,924,840**
Total LERRD Estimated Costs per Project *(rounded)*	**$161,475,615**		

12.0 Uniform Relocation Assistance (PL 91-646) for Displaced

Residences, Businesses and Farms

Within the preliminary project footprint, there are several residential structures that would have to be removed. Relocation assistance benefits to residents may be applicable including storage of household goods, moving costs, lodging, incidentals, differential payments, etc. Due to limited budget/schedule, on-site/detailed research was not performed, however, some preliminary relocation costs have been estimated based on PL 91-646 guidance (Federal Register, Volume 80 Issue) and the following assumptions and scope:

Residential structures (assume structures are owned by resident)
Moving costs (based on 6-room house)
Real Estate costs (recording fees, realtor's fee, appraisals, closing costs)

Comparable Housing Replacement (up to $22,500 allowed for differential pay if comparable housing is not available)

Based on the number of parcels identified as containing improvements based on County Assessor data (See Section 2), the following identifies an initial estimate associated with PL 91-646 using the assumptions above:

PL 91-646 Cost Factors	Duckabush River Estuary	Nooksack River Delta	North Fork Skagit River Delta
No. of affected residential structures	0	36	21
Improvements Value per Assessor	0	$2,229,000	$2,963,300
Moving Costs *($1,600/residence)*	0	$57,600	$33,600
Real Estate Costs *($10,000/residence)*	0	$360,000	$210,000
Housing Replacement *($22,500/residence)*	0	$810,000	$472,500
Sub-Totals of Costs	0	*$3,456,600*	*$3,679,400*
Contingency (10%)	0	*$345,660*	*$367,940*
Total PL 91-646 Costs	**0**	**$3,802,260**	**$4,047,340**

13.0 Mineral Activity

The project lands consists primarily of agricultural, residential and river delta lands. In preliminary discussions with WDFW, there are no known outstanding mineral/mining interests or active mining operations in the project area that could affect implementation of the project. Further research will be performed during PED.

14.0 Non-Federal Sponsor Capability Assessment

The NFS has exhibited land acquisition experience on projects throughout Washington State, and is highly capable of acquiring lands to support the project and is considered fully capable of meeting the real estate requirements for the project. The Capability Assessment specifies WDFW has the option for power of eminent domain under the legislative provisions of RCW 77.12.037. As public meetings continue to be held during PED, the NFS will be able to gauge public willingness to provide the real estate interests required for the project. Based on feedback during the public meetings, and if essential, the NFS would engage early in the process to initiate the required legislative actions, enabling them to exercise the power of public domain, as needed. Previous projects that have involved WDFW include Deepwater Slough, Section 1135, Goldsborough Creek, Section 206 and, Issaquah Creek Fish Passage. Exhibit D provides an assessment of the NFS' real estate acquisition capability.

Article III of the Project Partnership Agreement (PPA) will require the NFS to make available to the Corps of Engineers (COE) all lands required for construction of the

proposed project. When the NFS completes and signs the Certification of Lands – Authorization for Entry and Attorney's Certificate (Exhibit E), the NFS certifies that it owns or controls a sufficient interest in the lands required for construction, and subsequent operation and maintenance of the subject project; and the NFS grants the COE permission to enter at reasonable times in a reasonable manner upon the subject lands for the purpose of constructing and performing operation and maintenance activities for the project.

15.0 Zoning Ordinances in Lieu of Acquisition

No zoning ordinances are currently proposed in lieu of, or to facilitate LERRD acquisition in connection with this project.

16.0 Acquisition Schedule

At this time, no schedule has been identified for development of the Project Partnership Agreement (PPA). Real Estate Acquisitions will begin once a PPA is fully executed between USACE and the NFS. The NFS will be asked to certify their minimum realty estate interests necessary to support the project construction and maintenance.

The following acquisition schedule is based on the premise that the project could potentially impact approximately 220 landowners and several utilities. Should all three (3) projects be initiated concurrently, the NFS could utilize the option to contract for services to meet the acquisition schedule. As stated in the Capability Assessment, the NFS has the ability to obtain contractor support (See Exhibit D). The schedule below provides the estimated total amount of time to complete the acquisition of real estate for the construction of the project features based on preliminary information available at this time. This schedule is only for purposes of the current feasibility study and will be updated during PED. Acquisition tasks may be performed concurrently, as applicable:

Rights-of-Entry (ROEs), Mapping	1-2 years
Obtain Title and Appraisals	2-3 years
Negotiations	2-3 years
Closing	1-2 years
LERRD Certification	1-2 years

17.0 Description of Facility/Utility Relocations

17.1(a). Duckabush River Estuary

Facility/Utility Identification, Ownership, Project Impact

The Hwy 101 bridge will be relocated to the west and Duckabush Road will be realigned both horizontally and vertically to connect with the new Hwy 101 bridge. A new bridge will replace the existing culvert at Shorewood Drive. The area has electricity, telephone and internet, which will be relocated to the new alignment of Hwy 101. The area does not have public water/sewer services – development relies on private septic systems and private/group wells.

17.1(b). Nooksack River Delta

Facility/Utility Identification, Ownership, Project Impact

Preliminary Utility/Public Facility relocations anticipated include the following:

- Ferndale Road at Lummi River
  - Realign portion of roadway
  - Install new bridge over Lummi River
- Slater Road at Lummi River
  - Realign portion of roadway
  - Install new bridge over Lummi River
- Slater Road at Nooksack River
  - Install new bridge over Tennant Creek
- Hillaire Road at Lummi River
  - Realign portion of roadway
  - Install new bridge over Lummi River
- Imhoff Road at Lummi River
  - Realign portion of roadway
  - Install new bridge over Lummi River
- Haxton Way at Lummi River
  - Realign portion of roadway
  - Install new bridge over Lummi River
- Marine Drive
  - Raise road and add box culverts
- Utility Relocations
  - Water, Overhead Power, Telecommunications

17.1(c). North Fork Skagit River Delta

Facility/Utility Identification, Ownership, Project Impact

The utilities in the area appear to be related to existing structures identified for removal. Consequently, the utilities associated with these structures would be removed/abandoned, as applicable, but are not considered relocation costs.

17.2 Preliminary or Final Attorney's Opinion of Compensability

Based on guidance contained in ER 405-1-12, Chapter 12, Paragraph 12-8.b, the actions identified in Section 17.1 and noted in the table below are considered utility/facility relocation costs. The total project cost is $452,286,000; Total relocation costs are $130,500,000, or 29% of the total project cost. Real Estate Policy Guidance Letter No. 31 indicates that if the costs of relocation of facilities and utilities do not exceed 30% of the total project costs, a preliminary compensable interest report is not required, however, once PED level of design is complete, a Final Attorney's Opinion of Compensability may be prepared at that time (See Exhibit F). Since the relocation costs are less than 30% of the total project costs, and in accordance with Policy Letter No 31, Paragraph 4.b.(1)(a)(b), a real estate assessment has been performed:

(a) Yes, the identified utility/facility are generally of the type eligible for compensation under the substitute facilities doctrine, and

(b) Yes, the affected utilities/facilities (roads) are assumed to be public ownership.

As a result of the real estate assessment, the cost of providing substitute facilities has developed. For the purposes of the current project phase, estimated relocation costs are identified in Table below.

PROJECT SITE	*UTILITY/FACILITY RELOCATION ACTION*	*ESTIMATED COST*	*TOTAL COST/SITE*
Duckabush River Estuary *(+ 46% contingency)*	Hwy 101 Relocation/ Duckabush Road Realignment	$41,681,380	$47,561,000
	Shorewood Road New Bridge	$5,244,320	
	Electrical/Telecommunications Relocation	$635,100	
Nooksack River Delta *(+ 40% contingency)*	Raise Road/Add Box Culverts	$27,489,000	$82,939,000
	New Bridges (6)	$41,293,000	
	New Utility Installation	$14,156,800	
North Fork Skagit River *(+ 30% contingency)*	No new utilities, demo/abandonment only	$0	$0
TOTAL ESTIMATED RELOCATION COSTS			**$130,500,000**

17.3 Conclusion/Categorization Studies

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REAL ESTATE PLAN, OR ELSEWHERE IN THIS PROJECT REPORT, THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES.

18.0 HTRW

A Phase I HTRW assessment was conducted for each of the 3 project sites. For ecosystem restoration projects, it is assumed the NFS will provide clean, uncontaminated lands. A summary of the assessment for each site is provided below:

18a. Duckabush River Estuary: A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.* The assessment was initially conducted by the USFWS in 2010, and completed by the U.S. Army Corps of Engineers (Corps) in 2015. This assessment has revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site. See the Duckabush River Estuary Engineering Appendix B for the complete Phase I assessment.

18b. Nooksack River Delta: A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.* The assessment was initially conducted in 2011 by the USFWS, and updated in 2015 by the U.S. Army Corps of Engineers (Corps). The assessment revealed several recognized environmental conditions in connection with areas adjacent to the project footprint, although all but one of these sites have no potential to impact the proposed project. The one exception is the Wilder Hazardous Waste Landfill site, located approximately a half mile east of the project footprint. There was determined to be a small risk of contaminants in the landfill being mobilized by flooding as a result of the proposed project. B Because detailed hydraulic modeling has not been completed, there is uncertainty about the potential of a hydraulic connection to the adjacent HTRW site in the future with-project condition. To resolve this uncertainty, hydraulic modeling will be completed during PED. See the Nooksack Engineering Appendix B for the complete Phase I assessment.

18c. North Fork Skagit River Delta: A Phase 1 Environmental Site Assessment was conducted in conformance with the scope and limitations of ASTM E1527-13: *Standard Practice for Environmental Site Assessments,* and ER 1165-2-132: *HTRW Guidance for Civil Works Projects.* The assessment was initially conducted in 2010 by the USFWS, and updated in 2015 by the U.S. Army Corps of Engineers (Corps). This assessment has revealed one potential recognized environmental condition in connection with the proposed project footprint, known as the Rexville Grocery site. However, due to the contaminants involved, degradation rates of those contaminants, topography, and the half mile distance between the Grocery and the subject property, this site is not expected to interact in any way with the proposed project. As a result, this assessment has revealed no evidence of recognized environmental conditions in connection with the proposed project footprint, nor any conditions at neighboring sites which have the potential to affect work at the project site. See the North Fork Skagit River Delta Engineering Appendix B for the complete Phase I assessment.

19.0 Landowner Attitude

Over the course of the project development, the NFS has been engaged with local ecosystem restoration organizations, to include the Tribes, Salmon Recovery Groups, local governments, etc. The support for the project from these organizations has been positive. A 90-day open public comment period was held on the PSNERP Draft Feasibility Report and Environmental Impact Statement (DFR/EIS) by the Corps of Engineers. The comment period ran from October 10, 2014 through January 8, 2015. The overall general consensus of the comments were mixed. All comments received during the public meeting have been recorded and considered in the development of the Final FR/EIS report. *(See Section 8 of the main report and Appendix H for specific comments).* The Corps and NFS will continue to include stakeholders and the public as additional information and design data becomes available during PED. The Nearshore Study also maintains a website (*www.pugetsoundnearshore.org*), which serves as the primary resource for information including study background, events, technical reports, program documents, and progress of the study.

20.0 Risks Associated with Advanced Land Acquisition

The NFS have been notified in writing of the risks of acquiring any additional lands for the project prior to the execution of the PPA *(Risk letters were sent to WDFW August 23, 2013).*

21.0 Additional Information

Due to the preliminary nature of the proposed project design footprint, title reports were not secured. A thorough title analysis will be conducted during PED to identify any Third Party Interests that may impede the appropriate land acquisition for the proposed project. All property interests acquired in support of the proposed project must take priority over any competing third party interests that could defeat or impair the NFS' title to the property or interfere with construction, operation and maintenance of the project. Such third party interests should be cleared from title, or subordinated to the interests being made available to the project by the NFS. Outstanding third party interests are unknown at this time.

EXHIBIT A

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT SITE OVERVIEW

PSNERP Sites

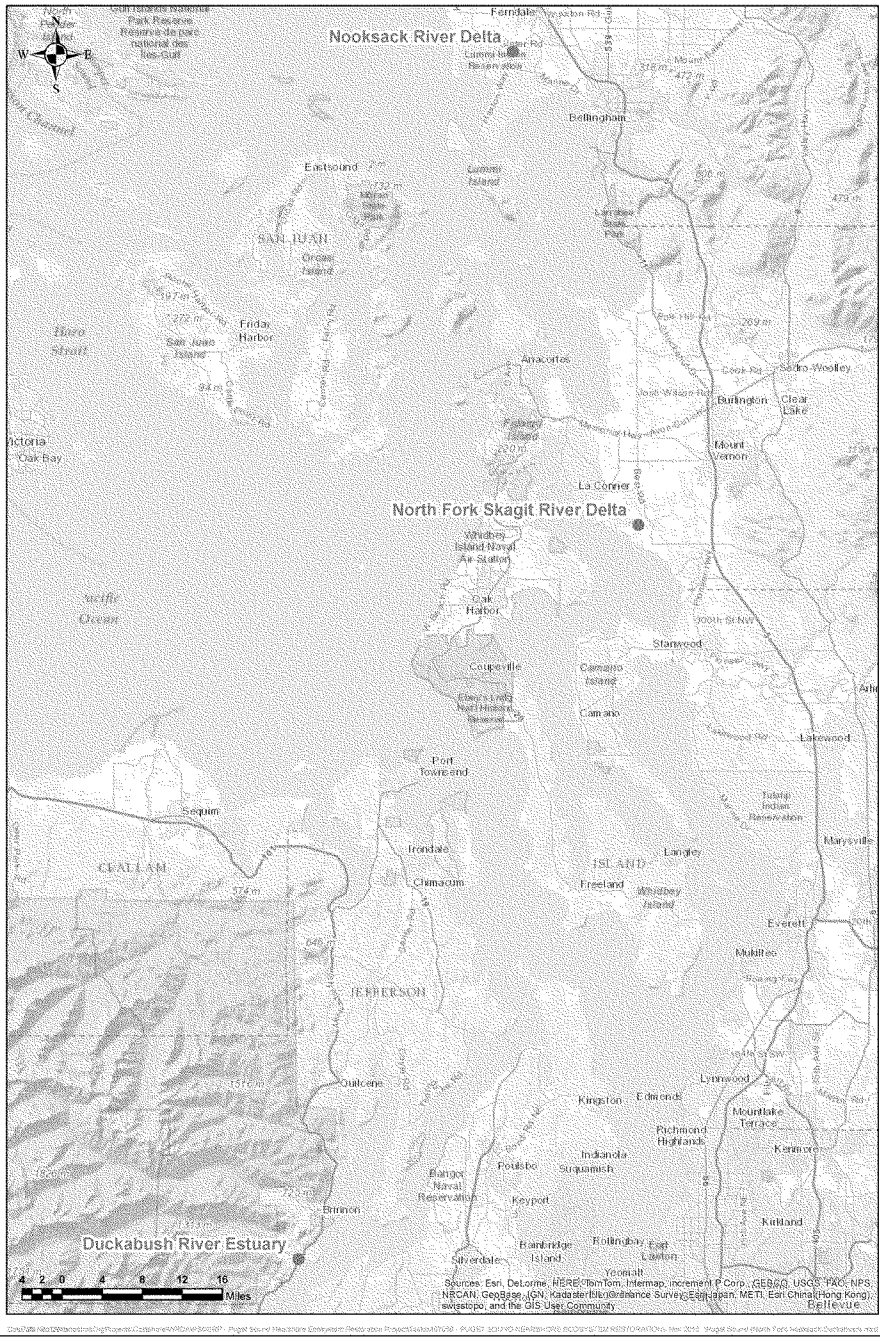
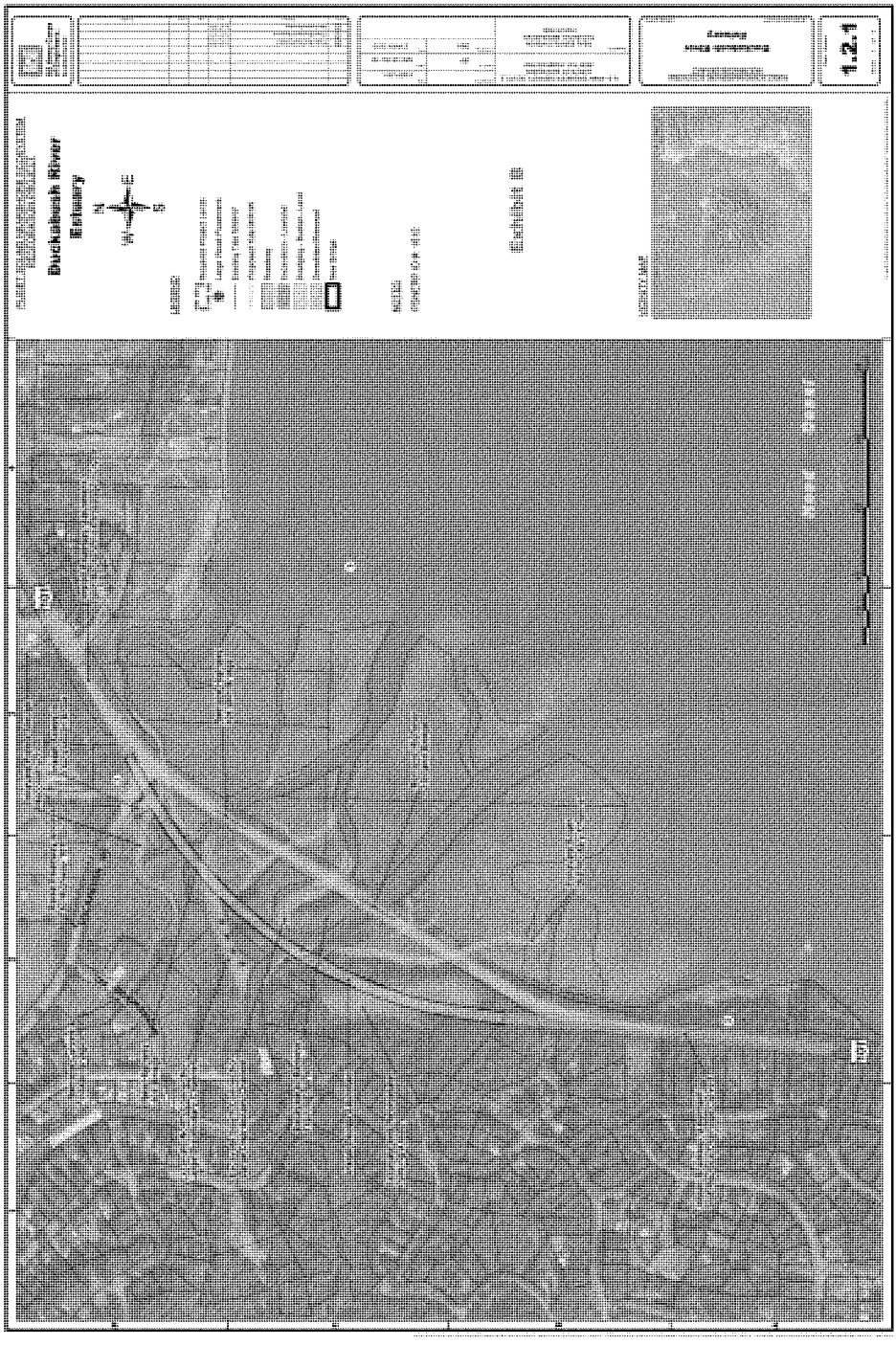
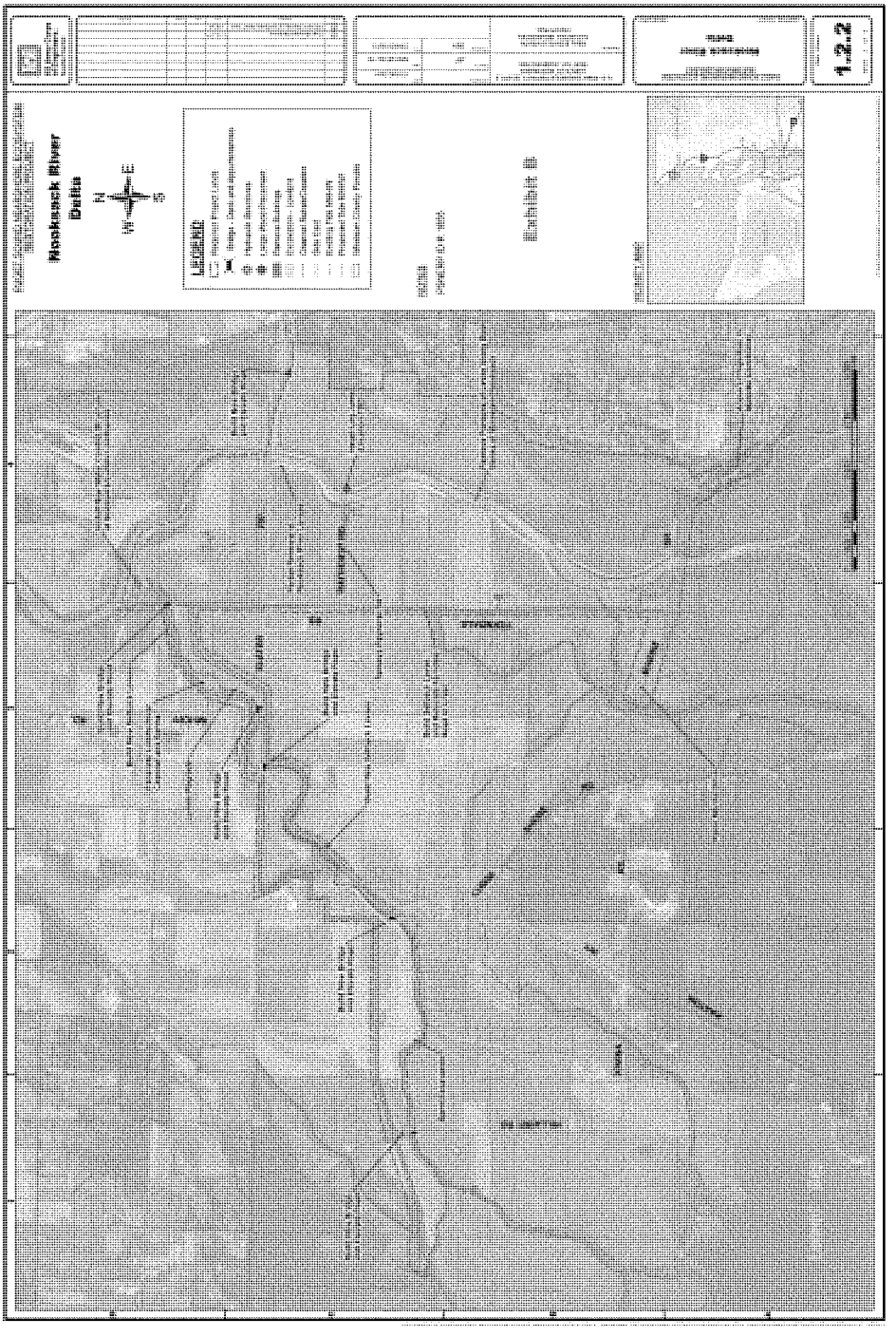


EXHIBIT B

REAL ESTATE MAPS

- **Duckabush River Estuary**
- **Nooksack River Delta**
- **North Fork Skagit River Delta**





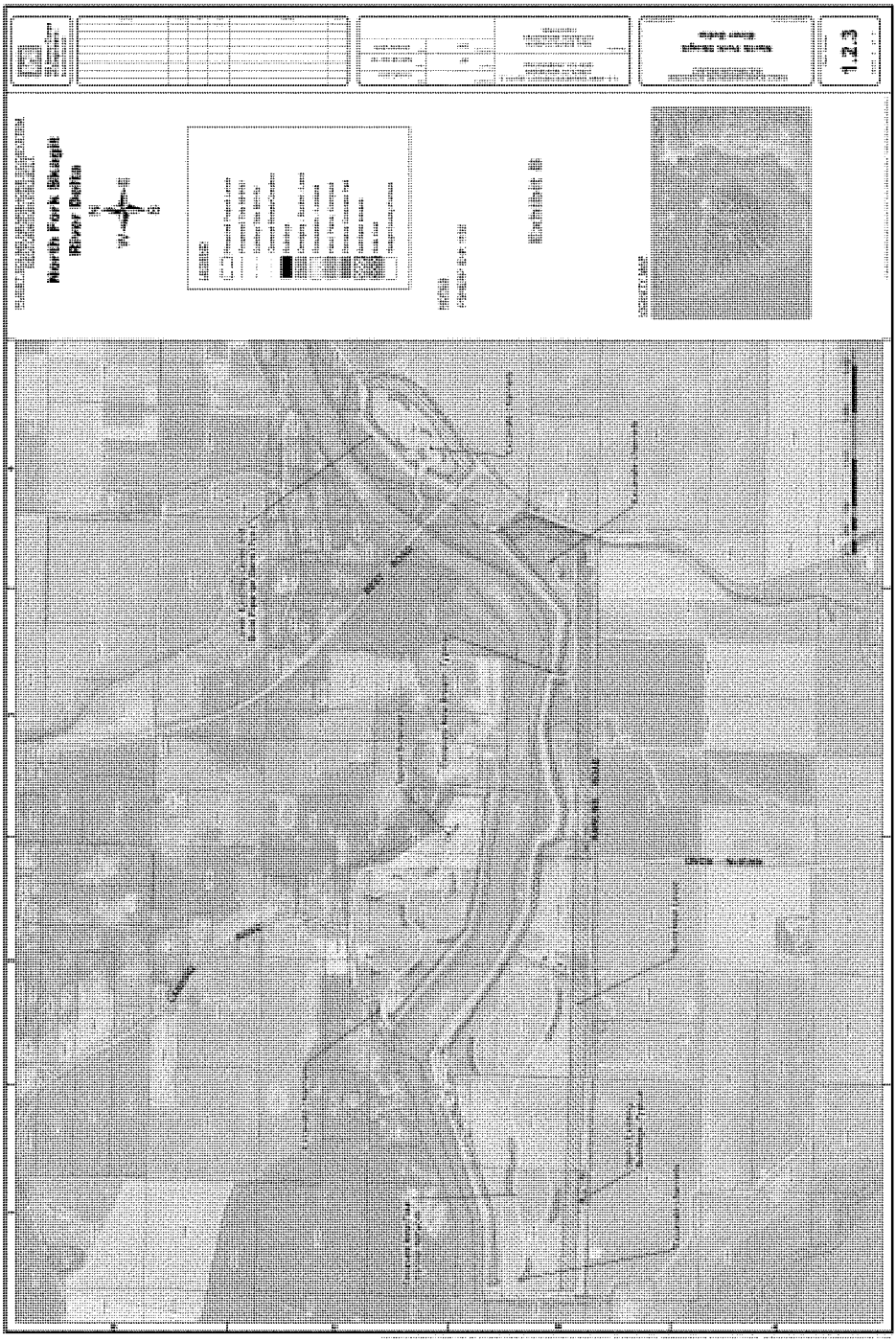

North Fork Skagit
River Delta
Exhibit B
1.2.3

EXHIBIT C

APPROVAL TO WAIVE APPRAISAL REQUIREMENTS FOR PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT, dtd 10 Jul 2012

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

CEMP-CR

JUL 10 2012

MEMORANDUM THRU Northwestern Division, U.S. Army Corps of Engineers, Attn: CENWD-RE, Jana Brinlee, 1125 NW Couch Street, Suite 500, Portland, OR 97208-2870

FOR Seattle District, U.S. Army Corps of Engineers, Attn: CENWS-RE-RS, Christopher Borton, 4735 East Marginal Way South, Seattle, WA 98124-2385

SUBJECT: Information Paper and Request for Approval to Waive Appraisal Requirements for Puget Sound Nearshore Ecosystem Restoration Project

1. References:

a. EC 405-1-04, paragraph 4-21, Appraisal, dated 30 Dec 2003.

b. CECW-CP Memorandum, dated 8 Feb 2010, U.S. Army Corps of Engineers Civil Works Project.

2. Reference 1.a., paragraph 4-21 instructs that gross appraisals are generally required for feasibility studies. However, in full support of the Civil Works Planning Paradigm and Smart Planning (Reference 1.b.), your request to utilize cost estimates for 14 of the 15 sites (gross appraisal required for Livingston Bay only) are approved. Once the project is further defined, please ensure that any valuation products are developed and scaled based on the requirements, decision making, and risk management.

3. POC for this action is Tonya Bright at 202-761-4904.

FOR THE COMMANDER:

Enclosure

SCOTT L. WHITEFORD
Director of Real Estate

Printed on Recycled Paper

PUGET SOUND NEARSHORE

				DIRECTOR BULLETIN CRITERIA				PROPOSED CRITERIA*			
Sites:	Total Project Costs in Millions $$	RE COST	RE Total % of Project	WITHIN 5% CAP AND UNDER $1M	COST EST	BRIEF GROSS APRSL	GROSS APRSL	WITHIN 10% CAP OR UNDER $1M	COST EST	GROSS APPRAISAL	JUSTIFICATION FOR APPRAISAL
Beacon Field	2.90	204,000	7.05			Y		Y	Y		
Chambers	329.70	8,900,000	2.70				Y	Y	Y		
Deepwater	8.05	244,000	3.03	Y	Y			Y	Y		
Dear Harbor	6.35	675,000	10.68			Y		Y	Y		
Dugualla Bay	60.50	7,600,000	12.56				Y	N		Y	
Everett	409.00	10,709,000	2.62				Y	Y	Y		
Harper	14.05	264,000	1.88	Y	Y			Y	Y		
Livingston Bay	11.55	4,500,000	38.96				Y	N		Y	
Milton Island	5.00	203,000	4.06	Y	Y			Y	Y		
Nooksack	449.50	9,000,000	2.00				Y	Y		Y	Criteria allows can ask recommend appraisal due to tribal lands
Point Whitney	10.30	472,000	4.58	Y	Y			Y	Y		
Snow Salmon	42.00	2,300,000	5.48			Y		Y	Y		
Spencer	19.00	1,100,000	5.79			Y		Y	Y		
Tahuya	33.00	182,000	0.55	Y	Y			Y	Y		
Telegraph	210.00	11,900,000	5.67			Y		Y	Y		

* Proposed Criteria is what NWS wants considered for purposes of this project

The valuation results will be utilized in Decision Documents (see EC 405-1-04, 4-19 (b))

Time is of the essense for NWS to successfully complete real estate valuation by 30 Jun 2012.

EXHIBIT D

ASSESSMENT OF NON-FEDERAL SPONSOR REAL ESTATE ACQUISITION CAPABILITY

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

I. **Legal Authority:**

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? YES/NO

b. Does the sponsor have the power of eminent domain for this project? YES/NO
However, there is a vehicle to secure this option, if needed, via RCW 77.12.037.

c. Does the sponsor have "quick-take" authority for this project? YES/NO

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? YES/NO
The project is within Washington state.

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? YES/NO
The Lummi Nation owns some of the project lands. They have indicated support for the project and have been an engaged partner.

II. **Human Resources Requirements:**

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? YES/NO

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? YES/NO N/A

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? YES/NO

d. Is the sponsor's projected in-house staff level sufficient considering its other work load, if any, and the project schedule? YES/NO

e. Can the sponsor obtain contractor support, if required, in a timely fashion? YES/NO

f. Will the sponsor likely request USACE assistance in acquiring real estate? YES/NO (If "yes," provide description).

III. **Other Project Variables:**

a. Will the sponsor's staff be located within reasonable proximity to the project site? YES/NO

b. Has the sponsor approved the project/real estate schedule/milestones? YES/NO

Sections I, II, III prepared by:

Theresa Mitchell 3/7/16
Theresa Mitchell
PSNERP Project Manager

Sections I, II, III reviewed/approved by NFS

Clay Sprague
Lands Division Manager

Sections IV/V to be completed jointly by NFS and USACE Real Estate Specialist

IV. **Overall Assessment:**

a. Has the sponsor performed satisfactorily on other USACE projects? YES/NO

b. With regard to this project, the sponsor is anticipated to be:

- ✓ Highly capable
- ___ Fully capable
- ___ Moderately capable
- ___ Marginally capable
- ___ Insufficiently capable. (If sponsor is believed to be "insufficiently capable" provide explanation).

V. **Coordination:**

a. Has this assessment been coordinated with the sponsor? YES/NO

b. Does the sponsor concur with this assessment? YES/NO
(If "no," provide explanation).

Prepared by:

Diane B. Hintz
Realty Specialist

Reviewed and approved by:

~~Christopher D. Berton~~ PATRICIA M. FATHEREE 3/21/2016
Chief, Real Estate Division

EXHIBIT E

DRAFT CERTIFICATION OF LANDS, ATTORNEY'S CERTIFICATE AND THIRD PARTY RISK ANALYSIS

DATE

Department of the Army
Seattle District, Corps of Engineers
ATTN: Real Estate Division
Post Office Box 3755
Seattle, Washington 98124-3755

RE: Certification of Lands and Authorization for PROJECT NAME located in LOCATION DESCRIPTION (City/County)

Dear Ladies and Gentlemen:

By Project Partnership Agreement dated the DATE OF PPA, the NAME OF NON-FEDERAL SPONSOR assumed full responsibility to fulfill the requirements of non-federal cooperation as specified therein and in accordance with the NAME OF PROJECT AUTHORITY, as amended.

This is to certify that the NAME OF NON-FEDERAL SPONSOR has sufficient title and interest in the lands hereinafter shown on Exhibit A, attached, in order to enable the NAME OF NON-FEDERAL SPONSOR to comply with the aforesaid requirements of non-federal cooperation.

Said lands and/or interest therein are owned or have been acquired by the NAME OF NON-FEDERAL SPONSOR, and are to be used for the construction, maintenance and operation of the above referenced project and include but are not limited to the following specifically enumerated rights and uses, except as hereinafter noted:

1. NAME, LANGUAGE OF PROPOSED REAL ESTATE INTERESTS

2.

ETC.

The NAME OF NON-FEDERAL SPONSOR does hereby grant to the United States of America, its representatives, agents and contractors, an irrevocable right, privilege and permission to enter upon the lands hereinbefore mentioned for the purpose of prosecuting the project.

The Public Sponsor certifies to the United States of America that any lands acquired subsequent to the execution of the Cooperation Agreement that are necessary for this project have been accomplished in compliance with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (Public Law 91-646) as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR, Part 24.

NON-FEDERAL SPONSOR AND CITY/STATE

DATE: _____

BY: _____
NON-FEDERAL SPONSOR SIGNATOREE
TITLE

ATTORNEY'S CERTIFICATE

RE: Certification of Lands and Authorization for PROJECT NAME *located in* LOCATION DESCRIPTION (City/State)

I, _____, an attorney admitted to practice law in the State of _____ certify that:

I am the attorney for the NON-FEDERAL SPONSOR AND CITY/STATE (hereinafter referred to as the "Public Sponsor").

I have examined the title to _____ [Parcel # (s)] of land identified by the U.S. Army Corps of Engineers as needed for the NAME OF PROJECT, located on the LOCATION DESCRIPTION and included in the Certification of Lands and Authorization for Entry document to which this Certificate is appended.

The Public Sponsor is vested with sufficient title and interest in the described lands required by the United States of America to support the construction, operation, and maintenance of the NAME OF PROJECT.

There [ ] are (see attached risk analysis) [ ] are no outstanding third party interests of record that could defeat or impair the title and interests of the Public Sponsor in and to the lands described, or interfere with construction, operation, and maintenance of the Project. Such interests include, but are not limited to, public roads and highways, public utilities, railroads, pipelines, other public and private rights of way, liens and judgments. To the extent such interests existed prior to acquisition of the described lands by the Public Sponsor such interests have either been cleared or subordinated to the title and interests so acquired except as provided in the attached risk analysis.

The Public Sponsor has authority to grant the Certification of Lands and Authorization for Entry to which this Certificate is appended; that said Certification of Lands and authorization for entry is executed by the proper duly authorized authority; and that the authorization for entry is in sufficient form to grant the authorization therein stated.

DATED AND SIGNED at _____, this ____ day of _____ 20__.

_____
NAME OF ATTORNEY FOR NFS
Attorney

RISK ANALYSIS FOR OUTSTANDING THIRD PARTY INTERESTS

RE: Certification of Lands and Authorization for ___*PROJECT NAME*___ *located in* ___*LOCATION DESCRIPTION (City/State)*___

There are outstanding third party interests of record in and to the lands required for the Project. An evaluation of those interests is as follows:

1. **IDENTIFICATION OF THIRD PARTY INTERESTS:**

2. **ASSESSMENT:** (Discuss whether the exercise of that interest is likely to physically impair the Project. Discuss the legal implications if the interest is not cleared or subordinated. Discuss the practical impediments to the exercise of the interest such as any required permits, land use restrictions, or compensation.)

3. **PLAN TO RESOLVE:** (Discuss recourse available to protect the Project in the event the outstanding interest is exercised).

Signed:

DATE _____

NAME OF ATTORNEY FOR NFS
Attorney

EXHIBIT F

REAL ESTATE POLICY GUIDANCE LETTER NO. 31

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET NW
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CEMP-CR

JAN 10 2013

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Real Estate Policy Guidance Letter No. 31-Real Estate Support to Civil Works Planning Paradigm (3x3x3)

1. References.

a. Memorandum, CECW-CP, 8 February 2012, Subject: U.S. Army Corps of Engineers Civil Works Feasibility Study Program Execution and Delivery

b. ER 5-1-11, USACE Business Process, 1 November 2006

c. EC 405-1-04, Appraisal, 30 Dec 2003

d. ER 1105-2-100, Planning Guidance Notebook, 22 Apr 2000

e. ER 405-1-12, Chapter 12, Real Estate Roles and Responsibilities for Civil Works, Cost Shared and Full Federal Projects, Change 31, 1 May 1998

2. Purpose. In accordance with reference a, this memorandum provides interim policy and guidance for real estate efforts associated with feasibility studies under the new Planning Paradigm, "SMART Planning," and the 3x3x3 rule. In accordance with the 3x3x3 rule, all feasibility studies should be completed within three years, at a cost of no more than $3 million, utilize three levels of vertical team coordination, and be of a "reasonable" report size.

3. Background. Real Estate has been fully engaged in the implementation of the 3x3x3 by actively participating in each webinar, the planning modernization workshop, and serving as part of the HQ Transition Team. In accordance with references b-e, Real Estate involvement is essential to the development and implementation of any pre-authorization project. Paragraph 12-16 of reference e. outlines the significant topics that must be covered in a real estate plan (REP). The level of detail necessary to apply the requirements of real estate policy and guidance will vary depending on the scope and complexity of each project.

As outlined in Chapter 12, the minimum interests in real property necessary to support various types of projects must be identified. As projects are scoped at the beginning of the feasibility phase (via a Charette or other forum), it is essential that Real Estate become familiar with the project authority and purposes to make a determination of the minimum interests and estate(s), both standard and non-standard, necessary as projects are scoped and alternatives evaluated. If a

non-standard estate will be needed, this should be discussed with MSC and HQ Real Estate as early as possible to ensure that the justification is sound and will serve the project purpose.

4. Policy. Typically, the attorney's preliminary opinion of compensability and gross appraisals are two areas that require more detail than may be readily available during the start of the feasibility phase, and are critical to determination of accurate estimates for real estate and total project costs. Due to the focus on 3 years or less for study duration, it will be essential for Real Estate to be adaptable and scale its requirements, decision making, and risk management in proportion to the significance of total project costs.

a. Gross Appraisals:

Specific to gross appraisals, EC 405-1-04 provides that cost estimates are utilized for preliminary planning of projects and in other cases, brief gross appraisals are acceptable. For purposes of the feasibility phase, the detail will vary as outlined below.

(1) For projects in which the value of real estate (lands, improvements, and severance damages) are not expected to exceed ten percent of total project costs (total cost to implement project), a cost estimate (or rough order of magnitude) will be acceptable for purposes of the feasibility phase.
(2) For projects in which the value of real estate (lands, improvements, and severance damages) do not exceed 30 percent of total project costs (total cost to implement project), a brief gross appraisal will be acceptable for purposes of the feasibility phase. A brief gross appraisal will follow format issued by Chief Appraiser.
(3) For projects in which the value of real estate (lands, improvements, and severance damages) exceed 30 percent of total project costs (total cost to implement project), a full gross appraisal will be prepared in accordance with the appraisal regulation and guidance provided by EC 405-1-04 and the Chief Appraiser.

b. Attorney's Opinion of Compensability:

As described in paragraph 12-17 of Chapter 12, utility/facility relocations may require preliminary attorney's opinions of compensability. While the practice of obtaining preliminary attorney's opinions of compensability provides a high degree of certainty with regard to project costs during the feasibility phase, such opinions can be time consuming and may provide more certainty than may be optimal for feasibility purposes when potential utility/facility relocation costs do not constitute a large percentage of total project costs. In support of the goals set out in the new planning paradigm described in reference a., Districts shall adhere to the following guidance:

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(1) Where the estimated total cost to modify all project utility facility relocations, including the value of any additional lands that may be required to perform the relocations does not exceed 30 percent of estimated total project costs, the District Office of Real Estate shall, in lieu of an attorney s opinion of compensability prepare a real estate assessment. Such a real estate assessment, will address the following questions:

(a) Is the identified utility facility generally of the type eligible for compensation under the substitute facilities doctrine (e.g., school, highway, bridge, water and sewer systems, parks, etc.)
(b) Does the District have some valid data or evidence that demonstrates that it has identified an owner with a compensable interest in the property

If the answer to both questions is yes, then the District Office of Real Estate shall reflect the cost of providing a substitute facility in the Real Estate Plan (REP) and all other feasibility study cost estimates. If the answer to either or both questions is no, the District shall not reflect the cost of a substitute facility in the REP or other feasibility study cost estimates. However, the REP narrative should still include a discussion on the facility with results of analysis and project impact. For cost shared projects, the non-federal sponsor must be advised that the inclusion of substitute facilities costs in the REP or other use feasibility study estimates is for planning and budgeting purposes only and does not constitute a preliminary or final determination of compensability by the agency regardless of whether the cost of substitute facilities are reflected in the feasibility study documents. Using a real estate assessment does not eliminate the need to obtain a final attorney s opinion of compensability prior to execution of the PPA.

(2) Where the estimated total cost to modify all project facility relocations, including the value of any additional lands that may be required to perform the relocations, has public or political significance or the costs exceed 30 percent of estimated total project costs, a preliminary opinion of compensability shall be prepared for each owner s facilities. The level of documentation for each relocation item should be based on the significance of the relocation item to project formulation and estimated project costs.

Real Estate products, such as the REP, must be adaptable and scaled based on the project scope. Additionally, Real Estate must utilize the risk register to highlight areas where cost, schedule or uncertainty is greater in order to manage risk. Going forward, the Real Estate Division will continue to work closely with the Planning and Policy Division, Engineering and Construction Division, the Programs Integration Division and the National Law Firm on the Planning SmartGuide. This SmartGuide will provide more on procedures, tips, techniques and tools for

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specific types of planning projects to aid in implementation of the new Planning Paradigm. All bulletins and updates on the SmartGuide can be found at: http://planning.usace.army.mil/toolbox/.

5. Duration. The policies stated herein will remain in effect until amended or rescinded by Policy Memorandums, Policy Guidance Letters, Engineers Circulars or Engineer Regulations.

FOR THE COMMANDER:

SCOTT L. WHITEFORD
DIRECTOR OF REAL ESTATE

DISTRIBUTION:
COMMANDER,
GREAT LAKES AND OHIO RIVER DIVISION (CELRD-PDS-R)
MISSISSIPPI VALLEY DIVISION (CEMVD-TD-R)
NORTH ATLANTIC DIVISION (CENAD-PD-E)
NORTHWESTERN DIVISION (CENWD-PDS)
PACIFIC OCEAN DIVISION (CEPOD-RE)
SOUTH ATLANTIC DIVISION (CESAD-PDS-R)
SOUTH PACIFIC DIVISION (CESPD-ET-R)
SOUTHWESTERN DIVISION (CESWD-ET-R)

CF:
COMMANDER,
DETROIT DISTRICT (CELRE-RE)
HUNTINGTON DISTRICT (CELRH-RE)
LOUISVILLE DISTRICT (CELRL-RE)
NASHVILLE DISTRICT (CELRN-RE)
PITTSBURGH DISTRICT (CELRP-RE)
MEMPHIS DISTRICT (CEMVM-RE)
NEW ORLEANS DISTRICT (CEMVN-RE)
ROCK ISLAND DISTRICT (CEMVR-RE)
ST. LOUIS DISTRICT (CEMVS-RE)
ST. PAUL DISTRICT (CEMVP-RE)
VICKSBURG DISTRICT (CEMVK-RE)
BALTIMORE DISTRICT (CENAB-RE)
NEW ENGLAND DISTRICT (CENAE-RE)
NEW YORK DISTRICT (CENAN-RE)
NORFOLK DISTRICT (CENAO-RE)

CEMP-CR
SUBJECT: Real Estate Policy Guidance Letter No. 31-Real Estate Support to Civil Works Planning Paradigm (3x3x3)

KANSAS CITY DISTRICT (CENWK-RE)
OMAHA DISTRICT (CENWO-RE)
PORTLAND DISTRICT (CENWP-RE)
SEATTLE DISTRICT (CENWS-RE)
WALLA WALLA DISTRICT (CENWW-RE)
ALASKA DISTRICT (CEPOA-RE)
HONOLULU DISTRICT (CEPOH-PP-RE)
JACKSONVILLE DISTRICT (CESAJ-RE)
MOBILE DISTRICT (CESAM-RE)
SAVANNAH DISTRICT (CESAS-RE)
ALBUQUERQUE DISTRICT (CESPA-RE)
LOS ANGELES DISTRICT (CESPL-RE)
SACRAMENTO DISTRICT (CESPK-RE)
FORT WORTH DISTRICT (CESWF-RE)
GALVESTON DISTRICT (CESWG-RE)
LITTLE ROCK DISTRICT (CESWL-RE)
TULSA DISTRICT (CESWT-RE)
CECC-R

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX D

CULTURAL RESOURCES

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps of Engineers®
Seattle District

PROGRAMMATIC OF AGREEMENT BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT LOCATED IN WASHINGTON STATE

INTRODUCTION

In order to address continuing degradation of nearshore ecosystems, the U.S. Army Corps of Engineers (Corps) in Partnership with Washington Department of Fish and Wildlife (WDFW) as the Non-Federal Sponsor plans to carry out the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP or Project). The current PSNERP general investigation is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). The purpose of the Project is to restore the natural functional processes (e.g. sediment movement and tidal hydrodynamics) of coastal wetlands and embayment areas.

The potential for historic properties to be affected by the Project has been acknowledged and preliminary steps have been taken to identify and evaluate properties that may be eligible for listing in the National Register of Historic Places (NRHP). In 2011, WDFW, through U.S. Fish and Wildlife Service (USFWS), funded and conducted cultural resource investigations for the Project as part of a larger study designed to provide baseline environmental information for 36 potential restoration sites with significant ecosystem degradation issues. These studies included a literature review, a reconnaissance inventory limited to public lands of 15 of the 36 potential restoration areas, and the development of a historic context for agricultural levees.[1] Of the 36 sites originally evaluated in early planning stages, three are now being recommended for construction authorization under the current Project. The remaining 33 sites will undergo their own Section 106 review at a future date under their respective restoration authorities and when appropriations have been secured, as applicable.

The Corps will seek Congressional authorization and appropriation necessary for the Project to move forward in the Corps Pre-Construction Engineering and Design phase (PED), where coordination of land access by WDFW, project design work, and engineering studies will occur. Based on feasibility level design, the following types of ecosystem restoration actions may occur, but are not limited to: removal of shoreline stabilization structures (such as existing levees) so that natural erosion can occur, construction of new setback levees, removal of standing structures that obstruct the natural conveyance of water, realignment of roads, removal of fill, and excavation of tidal channels. The Corps has concluded that a phased identification[2] is appropriate and necessary for the agency to comply with the National Historic Preservation Act (NHPA), and will therefore phase analysis, identification, and evaluation of historic properties until Congressional authorization and appropriations are received and further engineering studies and investigations are possible. A successful NHPA review of the Project will include careful

---

[1] *A Cultural Resource Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington Task 1: Literature and Data Review and Synthesis.* 2011. Dave Iversen, Shelby Gunderman and Nicholas Hanten; *A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington, Task 2: Historic Context of Agricultural Dikes.* 2011 Sarah Stringer-Bowsher, Dan Killoren, Shannon Davis and Dave Iversen; *Cultural Resources Field Inventory for 15 Action Areas within the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington.* 2011. David Iversen, Sarah Stringer-Bowsher, Shannon Davis, Jennifer Krintz, Nicholas Smith and Alicia Sawyer

[2] Phased identification: Section 106 regulations provide for phased identification of historic properties when circumstances may impede the completion of identification and evaluation prior to project approval. For PSNERP, the PA is the agreement document that is allowing Section 106 compliance during the feasibility phase with agreed-upon procedures for consideration of historic properties that will occur after Congressional approval and authorization but prior to construction

consideration of environmental, historic, cultural, economic, and social concerns. The Corps will work to avoid and/or minimize adverse effects to cultural resources to the greatest extent possible.

WHEREAS, the three restoration sites in the Project are the Duckabush River Estuary in Jefferson County, North Fork Skagit River Delta in Skagit County, and Nooksack River Delta in Whatcom County (Appendix A); and

WHEREAS, PSNERP will have the following acreage in restored wetland function, Duckabush River Estuary restoration site is approximately 38 acres in size and is located in Section 16 and 21 of Township 25 North, Range 2 West; the North Fork Skagit River Delta is approximately 256 acres in size and is located in Sections 8, 9, and 10 of Township 33 North, Range 3 East; and the Nooksack Delta is approximately 1807 acres in size and is located in Sections 1, 2, 3, 4, 5, 6, 7, 8, 10 and 11 in Township 38 North; Range 2 East and Section 31 and 32 of Township 39 North; Range 2 East; and

WHEREAS, the Corps has determined that the Project is a Federal Undertaking, consisting of one project with three restoration sites as described above, subject to review under Section 106 of the NHPA, 54 U.S.C. § 306108, and its implementing regulations under 36CFR § 800 (2004); and

WHEREAS, the Corps has concluded phased identification and evaluation that could take a number of years to complete is an appropriate and necessary approach for the agency to meet the requirements of Section 106 of the NHPA under 36 CFR § 800.4 (b) (2) and 36 CFR § 800.14 (b); and

WHEREAS, the Corps has determined the Area of Potential Effect (APE) for the Undertaking to be the Project boundary for each restoration site, plus any visual, direct, and indirect effects considered as documented in Appendix A; and

WHEREAS, The Corps and WDFW recognize that the Duckabush Bridge is a resource listed on the NRHP that will be affected by the proposed project, and the Corps and WDFW will continue to work through the Section 106 process outlined in the PA to resolve effects as they move through PED; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(1)(i)(C), the Corps has invited the Advisory Council on Historic Preservation (ACHP), to participate in the development of this Programmatic Agreement (PA); and per their letter dated March 22, 2013 the ACHP will participate in the development of a PA; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(1)(i)(C), the Corps has consulted with the Washington State Historic Preservation Officer (SHPO) about the agency's intent to implement the Project and has invited them to participate in the development of the PA by letter dated March 5, 2013. The SHPO agreed to participate in the development of a PA; and, responded by letter on April 3, 2013 stating that the SHPO would be working with the Corps and WDFW on development of this PA. The Corps followed up with a letter on September 30, 2015 to re-engage the SHPO; and

WHEREAS, the Lummi Nation through their Tribal Historic Preservation Officer (THPO), who has assumed the responsibilities of a SHPO per 36 CFR § 800.2(c)(2), is the official representative for purposes of Section 106 consultation and this PA as approximately 200 acres[3] of the Nooksack Delta site are located within Lummi Nation Tribal lands; and

[3] This number is based on the project footprint as of March 31, 2016. The acreage may increase or decrease depending on project footprint and real estate plan.

WHEREAS, WDFW is the Non-Federal Sponsor for the Project and has been consulted regarding potential historic properties and effects, and has been invited to participate in this Agreement as an Invited Signatory; and

WHEREAS, the Corps has invited the Washington State Department of Transportation (WSDOT) to participate in consultation regarding potential historic properties and effects at the Duckabush River Estuary site and has invited the agency to participate in this Agreement as an Invited Signatory; and

WHEREAS, the Corps has consulted with the following Tribes and offered them the opportunity to participate in this agreement as concurring parties: Jamestown S'Klallam Indian Tribe, Lower Elwha Klallam, Muckleshoot Tribe of Indians, Nisqually Indian Tribe, Nooksack Indian Tribe, Port Gamble S'Klallam Tribe, Puyallup Indian Tribe, Samish Indian Nation, Sauk-Suiattle Indian Tribe, Skokomish Tribe, Snoqualmie Tribe, Stillaguamish Tribe, Suquamish Tribe, Squaxin Island Tribe, Swinomish Indian Tribe, the Tulalip Tribe, the Upper Skagit Indian Tribe; and

WHEREAS, the Corps has notified the following entities, and offered them the opportunity to participate in this agreement as concurring parties: City of Bellingham Planning Division, Historic Bridge Foundation, Jefferson County Historical Society, Jefferson County Planning Department, National Trust for Historic Preservation, Quilcene Museum, Skagit County Historical Museum, Town of La Conner, Washington Trust for Historic Preservation, and Whatcom County Historical Society; and

WHEREAS, the Corps and the project stakeholders have used many public outreach tools including newspaper articles, speaking at conferences, hosting workshops for the public, and developing and maintaining a website (*www.pugetsoundnearshore.org*); all of these efforts will be enumerated in the final Environmental Impact Statement[4] for the project; and

WHEREAS, the Corps has determined that although the prior cultural resources work provides baseline data, additional research, field survey, and evaluation will be necessary; and

NOW, THEREFORE, the Corps, the SHPO, the ACHP, the WSDOT, the WDFW, and Lummi Nation agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the Undertaking on historic properties.

STIPULATIONS

The Corps shall ensure that the following measures are carried out:

I. GENERAL

A. Applicability

1. A Consulting Party will be recognized by the Corps as a Signatory, Invited Signatory, or a Concurring Party starting on the date the Consulting Party signs this PA as a Signatory,

[4] *Puget Sound Nearshore Ecosystem Restoration Study: Integrated Feasibility Report and Environmental Impact Statement*, USACE Seattle District, 2016. A copy of the EIS is accessible at *www.pugetsoundnearshore.org*.

Invited Signatory, or Concurring Party[5] and provides the Corps with a record of this signature.

a) In accordance with 36 CFR § 800.6(c)(1), a signatory has the sole authority to execute, amend, or terminate the agreement.
b) In accordance with 36 CFR § 800.6(c)(3), an invited signatory or a concurring party is a consulting party invited to concur in the agreement document but who does not have the authority to amend or terminate the agreement.
c) In accordance with 36 CFR § 800.6(a)(5), if any party requests that specific information shared with Corps be kept confidential, the Corps will comply to the extent allowed by law.

B. Notices

1. The Signatories, Invited Signatories, and Concurring Parties may send and accept official notices, comments, requests for further information and documentation, and other communications required by this PA by e-mail. If the size of an e-mail message is unusually large or an e-mail is returned to a Sender because its size prevents delivery, the Sender will contact the recipient(s) and determine alternative methods to deliver the message and/or its attachments.

2. Time sensitive information that is not sent by e-mail should be sent by overnight mail, courier, or be hand-delivered. The time frame for its review will be measured by the date the delivery is signed for by the individual recipient, the agency or organization representing the Signatory, Invited Signatory, or Concurring Party.

3. All references to time periods in this PA are in calendar days. If a review period included in this PA ends on a Saturday, Sunday, or Federal holiday, the review period will be extended until the first business day following the Saturday, Sunday, or Federal holiday.

4. If a Signatory, Invited Signatory, or Concurring Party does not comment during the time frames set out in this PA, the Corps will consider absence of comment as non-objection, and the Corps may proceed to the next step in the process without taking additional steps to seek comments from that party. In requesting comments, the Corps will include the calendar date for when the comments are due back, and relay the importance of responding within the timeframe.

5. It is the responsibility of each Signatory, Invited Signatory, and Concurring Party to immediately inform the Corps of any changes in the name, address, e-mail address or phone number of the point-of-contact for the Signatory, Invited Signatory, or Concurring Party. The Corps will forward this information to the Signatories, Invited Signatories, and Concurring Parties by e-mail. The failure by any party to this PA to notify the Corps of changes to their point-of-contact's information shall not be grounds for asserting that notice of a proposed action was not received.

[5] The following definitions are provided from 36 CFR § 800.6. All parties implementing this Programmatic Agreement will use the authority provided under 36 CFR § 800.14(b)(3); the definitions from 36 CFR § 800.6 provide sound regulatory framework.

6. If the Undertaking is located within their traditional lands and territories, the affected Tribes will be notified regarding proposed work at the three restoration sites.

7. Consulting parties will be notified of all activities (at all three of the restoration sites) within the Undertaking unless they have identified areas/sites they want to opt out of as per Appendix B which outlines the opt out procedures.

C. Roles and Responsibilities for the Corps, SHPO, Lummi Nation, WDFW, WSDOT, and ACHP

1. The Corps:

   a) Will be responsible for identifying historic properties located within the APEs of the three restoration sites.

   b) Will ensure Cultural Resources (CR) review is conducted by qualified professional staff as outlined in Stipulation I.D.1below.

   c) Will send out quarterly reports. Beginning at the start of PED and the construction phase, and every three months thereafter until completion of all mitigation treatments for any adverse effects, the Corps will send a project status via email to all consulting parties once every three months. This email will contain:

      (1) The project APE (with maps) if it has been altered;
      (2) Which activities under the Undertaking are under identification and evaluation by any party;
      (3) Which activities under the Undertaking are under consultation and resolution of adverse effects.

   d) Will coordinate cultural resource reports to send to SHPO and THPOs.

   e) Will conduct all project consultation with interested Tribes.

   f) Will ensure that all documentation generated as part of the NHPA process resulting from the Undertaking reviewed pursuant to this Agreement shall be consistent with applicable SHPO and Tribal guidelines and the confidentiality provisions of 36 CFR § 800.11(c).

   g) Recognizes that levees cannot be fully assessed until the prism is exposed during the construction phase. As such, the Corps will make a determination of eligibility (DOE) during the PED phase, and if needed, the Corps will re-consult with SHPO and THPOs, and will amend the determination during construction phase if additional information is uncovered, in accordance with 36 CFR § 800.13.

   h) Will notify all parties of contact and address changes pursuant to Stipulation I.B.5. above.

   i) Will ensure documents or studies prepared by a non-Federal party meet applicable standards and guidelines when making identifications of historic properties, determinations of eligibility, and determinations of effects.

j) Will ensure that Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), will be followed if Native American human remains and/or funerary items are discovered on federal land.

k) Will ensure that human remains and/or funerary objects discovered on state or private land will follow applicable Washington State laws.

2. The SHPO and THPO:

a) Will notify the Corps of contact and address changes pursuant to Stipulation I.B.5. above.

b) Will review the Corps' determination of the Areas of Potential Effect (APE), National Register eligibility determinations, and the Corps' effect findings and provide comments within timeframes required by this Agreement.

c) Will be available as a resource and for consultation through site visits, email requests, telephone conversations, or electronic media. In those instances where consultation with SHPO and THPO has occurred, the Corps will provide written notice to SHPO and THPO to confirm any decisions that were reached.

d) Will coordinate with the Corps to identify consulting parties, including any communities, organizations, or individuals that may have an interest in the Undertaking and effects on historic properties.

e) Will inform the Corps and WDFW of any changes to their documentation standards.

f) Will perform project review tasks within 30 days of receipt.

3. WDFW:

a) Will notify the Corps of contact and address changes pursuant to Stipulation I.B.5. above.

b) Will be responsible for coordinating land access to the project lands for each restoration site. Currently, the three sites are comprised of a mixture of private, state and tribal land ownership.

c) Will coordinate temporary access for CR personnel to complete all necessary field survey work in coordination with the Corps' requests.

d) Ensure CR review is conducted by qualified professional staff as outlined in Stipulation I.D.1below.

e) Will perform project review tasks within 30 days of receipt.

f) Will coordinate with landowner(s) regarding cultural resources located on privately owned land on a case-by-case basis. After the Federal interest period ends, landowner(s) retain ownership of cultural resources found on their land. WDFW will work with the

landowner(s) to ensure the landowner(s) know what options they have for donating any collected artifacts to interested museums, and can help coordinate the curation of items should a landowner choose to donate items to a museum.

4. WSDOT:

   a) Will notify the Corps of contact and address changes pursuant to Stipulation I.B.5. above.

   b) Will perform project review tasks within 30 days of receipt.

   c) Will identify WSDOT partnerships such as the Scenic Byways Program or other entities and parties that may have interest or authority in participating in the consultation of the Project.

   d) Will as early as possible as an invited signatory, inform the Corps and WDFW of any changes in construction implementation approach that would require Federal Highways Administration (FHWA) to become involved in the project and that would necessitate an amendment to this PA to include FHWA as an Invited Signatory to an amended PA.

   e) Will coordinate safe access to WSDOT owned structures and properties that may require investigation during cultural resource identification and evaluation efforts.

5. ACHP:

   a) Will review any Adverse Effect (AE) determination as required in CFR § 800.6(a)(1).

   b) Will participate in dispute resolution as required by Stipulation IV.B of this agreement.

D. Administrative Standards

1. Qualified Staff: All archaeological and historic survey, testing efforts, and evaluations will be conducted by or performed under the direct supervision of individuals whose qualifications meet the Secretary of the Interior's Professional Qualifications Standards (Professional Qualifications) set forth in Appendix A of 36 CFR § 61.

2. The Corps and WDFW may contract out all or parts of the work to a qualified professional consultant(s) as set forth in Appendix A of 36 CFR § 61. The Corps and WDFW are responsible for the work products prepared by consultants.

E. Documentation Standards

1. All documents generated as part of the NHPA process will be prepared using *Washington State Standards for Cultural Resources Reporting, 2015* or the most current version located on the SHPO website. These Documents will be uploaded and transmitted using Washington Information System for Architectural and Archaeological Records Data (WISAARD), or current version.

II. PRE-CONSTRUCTION SECTION 106 PROJECT REVIEW PROCESS

A. As Congress appropriates funding for PSNERP, the Corps will continue working through the Section 106 process for the project elements.

1. Define the Area of Potential Effect (APE):

   a) The Undertaking contains three sites with three separate APEs which are located at Duckabush River Estuary, North Fork Skagit River Delta, and Nooksack River Delta. The APEs are recorded and mapped in Appendix A.

   b) The current APEs for the project are conceptual; the Corps acknowledges that the APEs could change as further design is completed.

      (1) If the APEs grows to an area not previously identified, the Corps will include this area in Standard Project Review, as outlined in Stipulation II.A.2-3.

      (2) If the APEs are reduced to a degree that it no longer includes an area that was previously identified, the Corps will notify all consulting parties of the change of the APE. No further identification and evaluation will be conducted on the cultural resources that were located in the portion of the APE that was eliminated.

   c) The Corps will notify all parties of the proposed APEs before any fieldwork takes place. This notification will be an email with a narrative boundary description, and a map showing the APEs for each of the sites. Within 30 days, SHPO and THPO will provide comments on the proposed APEs as defined under Stipulation I.C.2.b.

2. Identification of Archaeological Resources:

   a) As of the date of this PA, a records search in WISAARD identified previously recorded archaeological sites and standing structures in and/or adjacent to the project footprints of the three restoration sites. Please see Appendix D for a list of previously recorded cultural resources identified in each of the three restoration sites. The previously recorded cultural resource information will be incorporated into the identification stage of fieldwork, if they are a part of the project APEs.

   b) Before fieldwork begins, the Corps will conduct a new records search in the WISAARD database to check if any additional archaeological sites and standing structures have been recorded since this PA was executed, and if any of these resources exist in any newly identified sections of the APE. If any of the APEs grow, the Corps will ensure that the SHPO and THPO are notified and given the chance to comment as defined under Stipulation I.C.2.b.

   c) Identification of Archaeological Resources:

(1) Background Research:
Prior to the onset of archaeological field work at a restoration site, the Corps will ensure that the results from the WISAARD records search will be reviewed to determine what additional, if any, work may be needed at each restoration site. Additional background research will incorporate and expand on the background research compiled thus far. The focus of the effort will be to collect and synthesize information regarding the environmental history and cultural history of the site and to aid in developing prehistoric and historic contexts against which the significance of potential archaeological resources may be measured. Environmental background research will entail a review of primary and secondary sources relevant to the environmental and geological processes that have shaped a restoration site, and a review of historic maps providing documentation of land use changes. The background research results will be used to determine the probability for the presence of archaeological resources within the APEs. Historic and Archaeological Context statements will be developed prior to fieldwork in order to develop research questions and guide fieldwork. See Appendix C for research parameters.

(2) Archaeological Fieldwork:
Prior to the survey, the Corps will ensure that existing fieldwork and background information will be reviewed in conjunction with project designs to guide the level of field efforts necessary at each restoration site. The archaeologist will attempt to locate all previously recorded archaeological sites and determine what (if any) additional fieldwork is necessary.

(3) Archaeological Phase I (Reconnaissance) Survey:
The Corps will ensure that surveys include pedestrian transects, at minimum, and presence/absence subsurface testing, as appropriate.

a. Transect intervals for the pedestrian survey and subsurface testing will be determined based on the probability for the presence of archaeological remains.
b. All pedestrian survey transects and presence/absence subsurface testing locations will be recorded using a GIS-based system.
c. No artifacts will be collected during the pedestrian survey or the presence/absence testing; instead, artifacts will be recorded and mapped in place and left in their original location.

(4) Archaeological Phase II (Intensive) Survey:
The Corps will ensure that if any additional testing is necessary to gain sufficient information on any archaeological site, a research design plan will be prepared that addresses the field methodology to be used, including a treatment plan to address inadvertent discoveries. The intent of Phase II Archaeological Testing is to determine

the eligibility of a site to the NRHP utilizing the least amount of ground disturbance to obtain the necessary information.

a. The field methodology will be designed to obtain the necessary information needed to make a DOE. This may provide details necessary to determine a site's limits/boundaries, function, structure, and/or integrity.

b. The site form will be updated to incorporate all new information.

c. Subsurface testing may include but is not limited to: auger probes, shovel probes, backhoe test pits, and/or 50x50 cm test units.

(5) Photographs:
The Corps will ensure that photos will be taken at each restoration site and will include, at a minimum, overview photographs of the area, representative photographs of site conditions, representative photographs of subsurface test units; and representative photographs of any artifacts that may be identified. If human remains are discovered, no photographs of the remains will be taken.

(6) Inventory Forms:
The Corps will ensure that Washington State Archaeological Inventory Site forms will be completed for newly identified archaeological sites. Forms for previously recorded sites will be updated. A Washington State Isolate form will be completed for identified isolates.

(7) Artifact Collection/Curation:
In general, artifact collection will be specified on a case-by-case basis. Should artifact collection be necessary during the Phase II (Intensive) survey or as part of a data recovery for mitigation (see appendix E), the Corps will ensure that artifact collection and curation will be included as part of the research plan and/or data recovery plan. Artifact curation will only occur during the Federal interest period of this project; all artifacts will be curated pursuant to 36 CFR § 79. When the Federal interest ends, the artifacts are the responsibility of the land owner. Any records generated by artifact collections are the property of the Federal government.

3. Identification of Built Environment Resources:

a) Prior to construction, the Corps will ensure that the historic context statement for levees is revised and expanded. Please see Appendix C for research requirements and report parameters.

b) For the purposes of this PA, the Corps will consider all structures over 45 years of age within the APEs in the identification process, along with structures that may possess

exceptional significance. A 45-year threshold anticipates that ecosystem restoration actions will commence no more than five years after an inventory's completion.

c) Before fieldwork begins, the Corps will re-check the WISAARD database to identify whether additional inventories have been added since this PA was executed, and to identify resources that may exist in any newly expanded APE. If any of the APEs grow, the Corps will ensure that the SHPO and THPO are notified and given the chance to comment as defined under Stipulation I.C.2.b.

d) All above-ground structures meeting the age criteria above will be surveyed and documented to a level sufficient to make a DOE.

e) Culverts not listed or determined eligible for listing in the NRHP, or located adjacent to or within a NRHP historic district, including linear historic properties such as historic roads and highways or dikes, built after 1945 will not be surveyed and evaluated per the ACHP "Program Comment for Common Post-1945 Concrete and Steel Bridges" provided the culverts fall within the scope of the Program Comment, i.e., are of the following types: 1) reinforced concrete boxes; 2) concrete box culverts; 3) concrete pipe culverts; or 4) steel pipe culverts.

f) Culverts built in 1945 or earlier will be surveyed to a level sufficient to make a DOE.

g) All submissions will utilize the SHPO's Historic Property Inventory Form (HPIF) system.

4. Evaluation and Eligibility:

a) The Corps will ensure that all elements of the built environment that are surveyed will be evaluated according to guidelines set forth in 36 CFR § 800.4(c)(1), as well as additional guidance provided in *National Register Bulletin 15; How to Apply the National Register Criteria for Evaluation*.

b) In addition to the above, the Corps will ensure that determinations of eligibility for levees will utilize the context developed in Stipulation II.A.3.a. of this PA.

5. Determination of Eligibility and Effects:

a) Findings of No Historic Properties Affected:

(1) The Corps will make a finding of "no historic properties affected" under the following circumstances:

(a) If no eligible or listed historic properties are present in the APEs;

(b) The Project is designed to avoid historic properties, including archaeological sites or properties of religious or cultural significance.

(2) The Corps will consult with SHPO, THPO, and copy WDFW, and participating consulting parties of this finding and provide supporting documentation in accordance with 36 CFR § 800.11(d) and applicable documentation standards. Unless any party objects to the finding pursuant to the appropriate timeframe outlined in Stipulation I.C. Roles and Responsibilities, the Section 106 review of the Undertaking will have concluded.

(3) If any party objects to the determination of eligibility:
(a) The Corps will consult with the objecting part to resolve the disagreement.

(b) If the objection cannot be resolved, the Corps will consult with the Keeper of the Register to make a DOE as outlined is 36 CFR § 63.

(4) If any party objects to a finding of "no historic properties affected":

(a) The Corps will consult with the objecting party to resolve the disagreement.

(b) If the objection is resolved, the Corps may proceed with the action in accordance with the resolution. The Corps may instead reconsider effects on the historic property by applying the criteria of adverse effect pursuant to Stipulation II.A.5.c.3., Resolution of Adverse Effect.

(c) If the Corps is unable to resolve the disagreement, it will forward the finding and supporting documentation to the ACHP and request that the ACHP review the Corps finding in accordance with 36 CFR § 800.4(d)(l)(iv)(A) through 36 CFR § 800.4(d)(l)(iv)(C). The Corps will consider the ACHP's recommendation in making its final determination. If the Corps final determination is to reaffirm its "no historic properties affected" finding, the Section 106 review of the Undertaking will have concluded. Otherwise, the Corps will proceed to Stipulation II.A.5.c.3., Resolution of Adverse Effect.

b) Findings of No Adverse Effect:

(1) The Corps will make a finding of "no adverse effect" under the following circumstances:

(a) If there are historic properties present in the APEs; and the Undertaking is designed to avoid any adverse effects to historic properties, including buildings, structures, objects, archaeological sites, or properties of religious or cultural significance to interested Tribes; or

(b) The Undertaking does not affect the character defining features of a historic property; or

(c) For an Undertaking with a low potential of affect to archaeological resources, the Corps may determine "no adverse effect", and may require archaeological monitoring. In these instances, an archaeological monitoring plan will be developed prior to construction.

(2) The Corps will consult with, SHPO/THPO, and copy WDFW, and participating consulting parties of this finding and provide supporting documentation in accordance with 36 CFR § 800.11(d) and applicable documentation standards. Unless any party objects to the finding pursuant to the appropriate timeframe outlined in Stipulation I.C. Roles and Responsibilities, the Section 106 review of the Undertaking will have concluded.

(3) If any party objects to the determination of eligibility:

(a) The Corps will consult with the objecting party to resolve the disagreement.

(b) If the objection cannot be resolved, the Corps will consult with the Keeper of the Register to make a DOE as outlined is 36 CFR § 63.

(4) If a party objects to a finding of "no adverse effect":
(a) The Corps will consult with the objecting party to resolve the disagreement.

(b) If the objection is resolved, the Corps may proceed with the action in accordance with the resolution. The Corps may instead reconsider effects on the historic property by applying the criteria of adverse effect pursuant to Stipulation II.A.5.c.3, Resolution of Adverse Effect.

(c) If the Parties are unable to resolve the disagreement, it will forward the finding and supporting documentation to the ACHP and request that the ACHP review the Corps' finding in accordance with 36 CFR § 800.4(d)(l)(iv)(C) and 36 CFR § 800.5(c)(3)(i-ii). The Corps will consider the ACHP's recommendation in making its final determination. If the Corps' final determination is to reaffirm its "no adverse effect" finding, the Section 106 review of the Undertaking will have concluded. Otherwise, the Corps will proceed to Stipulation II.A.5.c.3, Resolution of Adverse Effect.

c) Finding of Adverse Effect:

(1) The Corps will make a finding of "adverse effect" under the following circumstances:

(a) The Undertaking will adversely affect identified historic properties in the APEs, including properties of religious or cultural significance; and

(b) The Corps has tried to avoid or minimize the impact to the historic property through working with the design team and WDFW, but a successful alternative has not been identified as feasible to achieve the ecosystem restoration objectives at the site.

(2) The Corps will consult with SHPO/THPO, and copy WDFW, and participating consulting parties of this finding and provide supporting documentation in accordance with 36 CFR § 800.11(e) and applicable documentation standards. Unless any party objects to the finding pursuant to the appropriate timeframe outlined in Stipulation I.C. Roles and Responsibilities, the Section 106 process will proceed to the Resolution of Adverse Effects.

(3) Resolution of Adverse Effects: if the Corps determines that an Undertaking will adversely affect a historic property, it shall resolve the effects of the Undertaking in consultation with SHPO/THPO, and copy WDFW, participating consulting parties, and ACHP (if participating, once invited per 36 CFR § 800.6(a)(1)), by one of the following methods depending upon the nature and scale of the adverse effects as well as the determination of the historic property's significance on a local, state or national level.

(a) Abbreviated Consultation Process: After taking into consideration the nature of the historic properties affected and the severity of the adverse effect(s), the Corps may propose to resolve the adverse effect(s) of the Undertaking through the application of Treatment Measures outlined in Appendix E as negotiated with the consulting parties. The Corps will not propose to use the Abbreviated Consultation process if the Undertaking may affect a National Historic Landmark. The application of these Treatment Measures will not require the execution of a Memorandum of Agreement (MOA) or Programmatic Agreement.

(i) The Corps will notify the consulting parties in writing of its proposed use of a specific Treatment Measure, or combination of Treatment Measures with the intent of expediting the resolution of adverse effects and provide documentation as required by 36 CFR § 800.11(e) and subject to the confidentiality provisions of 36 CFR § 800.11(c), as well as provide the ACHP with an adverse effect notice in accordance with 36 CFR § 800.6(a)(l) and notify them of the Corps' intent to apply the Treatment Measure(s). Unless a consulting party or the ACHP objects within thirty (30) days of receipt of the Corp's proposal, the Corps will proceed with the use of Treatment Measure(s) and will complete Section 106 review.

(ii) If any of the consulting parties or the ACHP objects within the 15 day review and comment period to the resolution of adverse effects through the application of the Abbreviated Consultation Process, the Corps will consult further with the consulting parties to explore options for resolution of the adverse effect(s). If consultation is not successful after an additional 15 day period, the Corps will request the ACHP to join consultation (if they are not already participating), as outlined in 36 CFR § 800.6(b)(v). If no consensus is reached, the Corps will resolve the adverse effect(s) using procedures outlined below in Stipulation II.A.5.c.3.b, Memorandum of Agreement.

(iii) Because funding and implementation details of Treatment Measure(s) for specific activities within the Undertaking may vary, the Corps will provide written notice to the consulting parties within sixty (60) days of the completion of the Treatment Measure(s). This written notice will serve as confirmation that the Treatment Measure(s) for specific Undertaking have been implemented.

(b) Memorandum of Agreement (MOA): If the Abbreviated Consultation Process is determined infeasible or is objected to by any of the consulting parties, the Corps, in consultation with the other consulting parties, will develop an MOA in accordance with 36 CFR § 800.6(c) to stipulate treatment measures to avoid, minimize, and/or mitigate adverse effects on historic properties. If the ACHP was not previously notified of the adverse effect, the Corps will provide the documentation outlined in 36 CFR § 800.11(e) and the ACHP will have 15 days to review the documentation and determine if its participation is necessary to complete the consultation process. The MOA may also include feasible treatment measures that serve an equal or greater public benefit in promoting the preservation of historic properties in lieu of more traditional treatment measures that are not enumerated in Appendix E.

III. OTHER CONSIDERATIONS

A. Design Review for new structures:

Designs for new or replacement structures proposed in the vicinity of eligible historic structures or archaeological sites, planned as part of PSNERP (e.g. bridge, levee, etc.) will be submitted at the 35% level of completion to the SHPO/THPO and interested consulting parties. Updated drawings will be provided if the project footprint changes after development of the 35% design.

B. Implementation of the Undertaking:

The Corps may authorize construction activities including, but not limited to, those listed below, to proceed in specific geographic areas where there has been an Agency determination that there

is no potential to cause effects, as outlined in 36 CFR § 800.3(a)(1). Such construction activities may include:

1. Demarcation, set up, and use of staging areas for construction of the Undertaking.
2. Conduct geotechnical boring investigations or other geophysical and engineering activities.
3. Grading, staging areas, and any other project specific construction element.

C. Post-Review Discoveries

If properties are discovered during the construction phase that may be historically significant or unanticipated effects on historic properties are found, the Corps shall implement measures identified in a discovery plan that will be developed prior to construction. The discovery plan is outlined in Appendix C.

IV. IMPLEMENTATION OF THE AGREEMENT

A. Amendments:

1. The PA may be amended by Signatories in the following manner:

   a) Upon receipt of a request to amend this Agreement, the Corps will immediately notify the all consulting parties and initiate a 30 day period to consult on the proposed amendment, whereupon all the signatories shall consult to consider such amendments.

   b) If agreement to the amendment cannot be reached within the 30 day period, resolution of the issue may proceed by following the dispute resolution process in Stipulation IV.B. below.

   c) This Agreement may be amended when such an amendment is agreed to in writing by all Signatories.

   d) Amendments to this Agreement shall take effect on the date that they are fully executed by the Signatories.

   e) Modifications, additions, or deletions to the appendices made as a result of continuing consultation among the consulting parties do not require the Agreement to be amended.

2. Modifications, additions, or deletions to the appendices may be made in the following manner:

   a) The Corps, on its own behalf or on behalf of another Signatory or Invited Signatory, will notify all Signatory and invited Signatory parties to this Agreement of the intent to add to or modify the current Appendix or Appendices and shall provide a draft of the updated Appendix or Appendices to all Signatory and Invited Signatory parties.

b) If no Signatory party objects in writing within 15 days of receipt of the Corps' proposed addition or modification, the Corps will date and sign the amended Appendix and provide a copy of the amended Appendix to all Signatory and Invited Signatory parties.

B. Dispute Resolution:

1. Should any party to this Agreement object at any time to any actions proposed or the manner in which the terms of this Agreement are implemented, the Corps will consult with such party to resolve the objection.

2. If the Corps determines that such objection cannot be resolved, the Corps will forward all documentation relevant to the dispute, including the Corps' proposed resolution, to the ACHP.

3. The ACHP shall provide the Corps with its advice on the resolution of the objection within thirty (30) days of receiving adequate documentation. Prior to reaching a final decision on the dispute, the Corps will prepare a written response that takes into account any timely advice or comments regarding the dispute from the ACHP, signatories, invited signatories, and concurring parties, and provide them with a copy of this written response. The Corps will then proceed according to its final decision.

4. If the ACHP does not provide its advice regarding the dispute within the thirty (30) day time period, the Corps may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, the Corps will prepare a written response that takes into account any timely comments regarding the dispute from the signatories, invited signatories, and concurring parties to the PA, and provide them and the ACHP with a copy of such written response.

5. The Corps is responsible for implementing all other actions subject to the terms of this PA that are not the subject of the dispute.

C. Severability, Termination and Suspension:

1. In the event any provision of this Agreement shall be deemed contrary to, or in violation of, any applicable existing law or regulation of the United States of America and/or Washington State, only the conflicting provision(s) shall be deemed null and void, and the remaining provisions of the Agreement shall remain in effect.

2. Any Signatory may terminate this Agreement by providing 30 days' written notice to the other signatories and invited signatories, provided that the parties consult during this period to seek amendments or other actions that would prevent termination. If this Agreement is terminated, the Corps will comply with 36 CFR § 800. Upon such determination, the Corps

will provide all other signatories and invited signatories with written notice of the termination of this Agreement.

3. Any concurring party may notify the other Signatories and Invited Signatories that it is fully withdrawing from participation in the Agreement. Following such a withdrawal, the Corps will review the activities within the Undertaking that may affect historic properties of religious and cultural significance to any Tribe in accordance with 36 CFR § 800. Withdrawal from this Agreement by a concurring party does not terminate the Agreement. A concurring party that has withdrawn from the Agreement may at any time notify the Corps, SHPO, THPO, and WDFW, in writing, that it has rescinded its notice to withdraw from participation in the Agreement.

4. This Agreement may be terminated by the implementation of a subsequent Agreement that explicitly terminates or supersedes this Agreement, or by the Corps' implementation of Alternate Procedures, pursuant to 36 CFR § 800.14(a).

D. Duration and Extension:

1. The Agreement shall remain in effect from the date of final signature for a period not to exceed 20 years unless otherwise extended pursuant to Stipulation IV.D.2., or terminated pursuant to Stipulation IV.C.2. or IV.C.4. Severability, Termination and Suspension.

2. The Signatories may collectively agree in writing to execute this Agreement to cover additional calendar years, or portions thereof, provided that the original agreement has not expired or if the Agreement has expired while a new agreement is in preparation.

3. The Corps will communicate quarterly with all consulting parties as stated in Stipulation I.C.1.c.

E. Parties to this Agreement:

1. Should conditions of the Undertaking change such that other federal agencies, state agencies, Indian tribes, tribal organizations or other organizations or individuals not already party to this Agreement request in writing to participate, the Corps will notify the other consulting parties and consider the request to participate in the Agreement. If the Corps determines that the party should be invited to participate in this Agreement, the Corps will notify the requesting party in writing and the Agreement will be amended following the procedures in Stipulation IV.A. Amendments.

2. Should conditions of the Undertaking change such that a Signatory or Invited Signatory to this Agreement determines that its participation in the Undertaking is no longer required the party may withdraw from participation by informing the Corps. The Corps will inform the other parties to this Agreement of the withdrawal. Withdrawal of a Signatory or Invited

Signatory to the Agreement where its participation is no longer required for purposes of section 106 does not terminate the Agreement as described in Stipulation IV.C.2. Severability, Termination and Suspension.

3. Should a Concurring Party determine that its participation in the Undertaking and this Agreement is no longer warranted, the party may withdraw from participation by informing the Corps. The Corps will inform the other parties to this Agreement of the withdrawal. Withdrawal of a Concurring Party to the Agreement does not require an amendment of the Agreement.

Execution of this PA by the Corps and the SHPO and the THPO, and implementation of its terms evidence that the Corps has taken into account the effects of this undertaking on historic properties and afforded the ACHP an opportunity to comment.

SIGNATORY PAGE

**PROGRAMMATIC OF AGREEMENT
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE**

U.S. Army Corps of Engineers, Seattle District (Signatory)

John M. Buck Date 7 Jun 16

John G. Buck, Colonel, Corps of Engineers, District Commander

SIGNATORY PAGE

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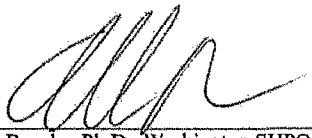
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE**

Washington State Department of Archaeology and Historic Preservation (Signatory)



Date 5/26/16

Allyson Brooks, Ph.D., Washington SHPO

SIGNATORY PAGE

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BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE**

Lummi Nation (Signatory)



Honorable Timothy Ballew II, Chairman

Date 6/3/16

SIGNATORY PAGE

**PROGRAMMATIC OF AGREEMENT
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE**

Advisory Council on Historic Preservation (Signatory)

John M. Fowler Date 6/16/16

John M. Fowler, Executive Director

INVITED SIGNATORY PARTIES

Washington Department of Fish & Wildlife
Washington State Department of Transportation
(Individual signature pages on succeeding pages)

SIGNATORY PAGE

PROGRAMMATIC OF AGREEMENT

BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION

FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT LOCATED IN WASHINGTON STATE

Washington Department of Fish & Wildlife (Invited Signatory)

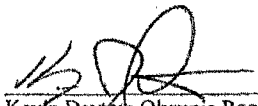
_____ Date 5/26/16

James Unsworth, Ph.D., Director

SIGNATORY PAGE

PROGRAMMATIC OF AGREEMENT
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE

Washington State Department of Transportation (Invited Signatory)



Date May 31, 2016

Kevin Dayton, Olympic Region Administrator

CONCURRING PARTIES

Historic Bridge Foundation
Samish Indian Nation
Stillaguamish Tribe
Washington Trust for Historic Preservation
(Individual signature pages on succeeding pages)

SIGNATORY PAGE

**PROGRAMMATIC OF AGREEMENT
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION
FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
LOCATED IN WASHINGTON STATE**

Historic Bridge Foundation (Concurring Party)



Date 5/27/16

Kitty Henderson, Executive Director

SIGNATORY PAGE

PROGRAMMATIC OF AGREEMENT

BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION

FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT LOCATED IN WASHINGTON STATE

Washington Trust for Historic Preservation (Concurring Party)

Chris Moore, Executive Director Date 6/6/16

SIGNATORY PAGE

PROGRAMMATIC OF AGREEMENT

BETWEEN THE U.S. ARMY CORPS OF ENGINEERS, THE WASHINGTON STATE DEPARTMENT OF ARCHAEOLOGY AND HISTORIC PRESERVATION, THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE, WASHINGTON DEPARTMENT OF TRANSPORTATION, AND THE LUMMI NATION

FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT LOCATED IN WASHINGTON STATE

Samish Indian Nation (Concurring Party)

_____ Date_____

Thomas D. Wooten, Samish Tribal Chairman

SIGNATORY PAGE

PROGRAMMATIC OF AGREEMENT

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FOR THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT LOCATED IN WASHINGTON STATE

Stillaguamish Tribe (Concurring Party)

_____ Date_____

Shawn Yanity, Stillaguamish Tribal Chairman

APPENDIX A

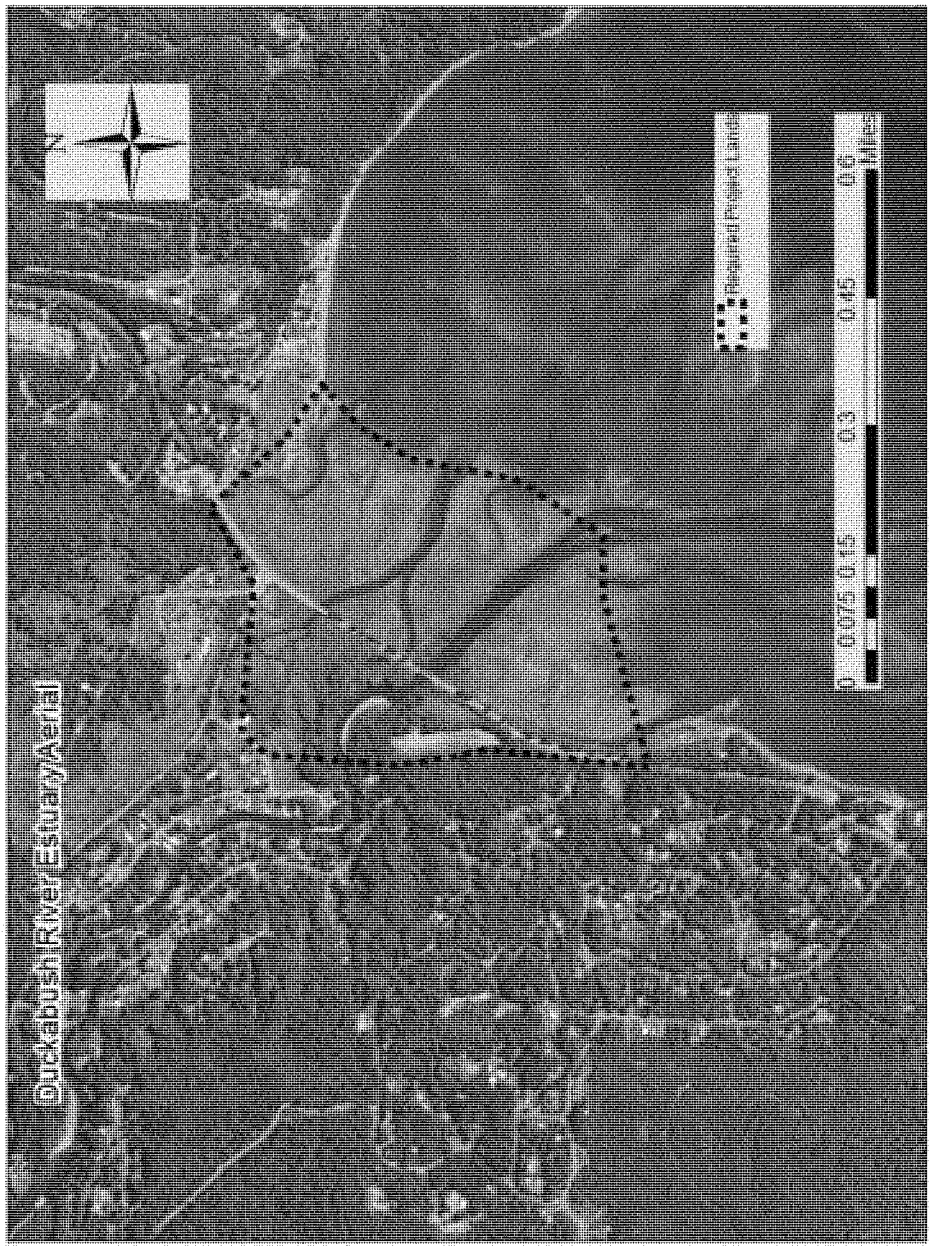
Area of Potential Effects for Duckabush River Estuary, North Fork Skagit River Delta and Nooksack River Delta

As of the date of this PA, the three restoration sites associated with the current Project each have an APE that was drawn to take into account the direct, indirect, and visual effects, as well as Traditional Cultural Properties (TCPs). To date no TCPs are known to be located in or adjacent to the APEs for each restoration site. Additional work is necessary to determine if TCPs are present. The current APEs are as follows:

(1) Duckabush River Estuary Site, Jefferson County: is approximately 38 acres in size and is located is Section 16 and 21 of Township 25 North, Range 2 West;

(2) North Fork Skagit River Delta Site, Skagit County: is approximately 256 acres in size and is located Sections 8, 9, and 10 of Township 33 North, Range 3 East;

(3) Nooksack River Delta Site, Whatcom County: is approximately 1807 acres in size and is located in Sections 1, 2, 3, 4, 5, 6, 7, 8, 10 and 11 in Township 38 North; Range 2 East and Section 31 and 32 of Township 39 North; Range 2 East; Sections 1, 2, 3, 4, 5, 6, 7, 8, 10 and 11 in Township 38 North; Range 2 East and Section 31 and 32 of Township 39 North; Range 2 East.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N
Required Project Lands
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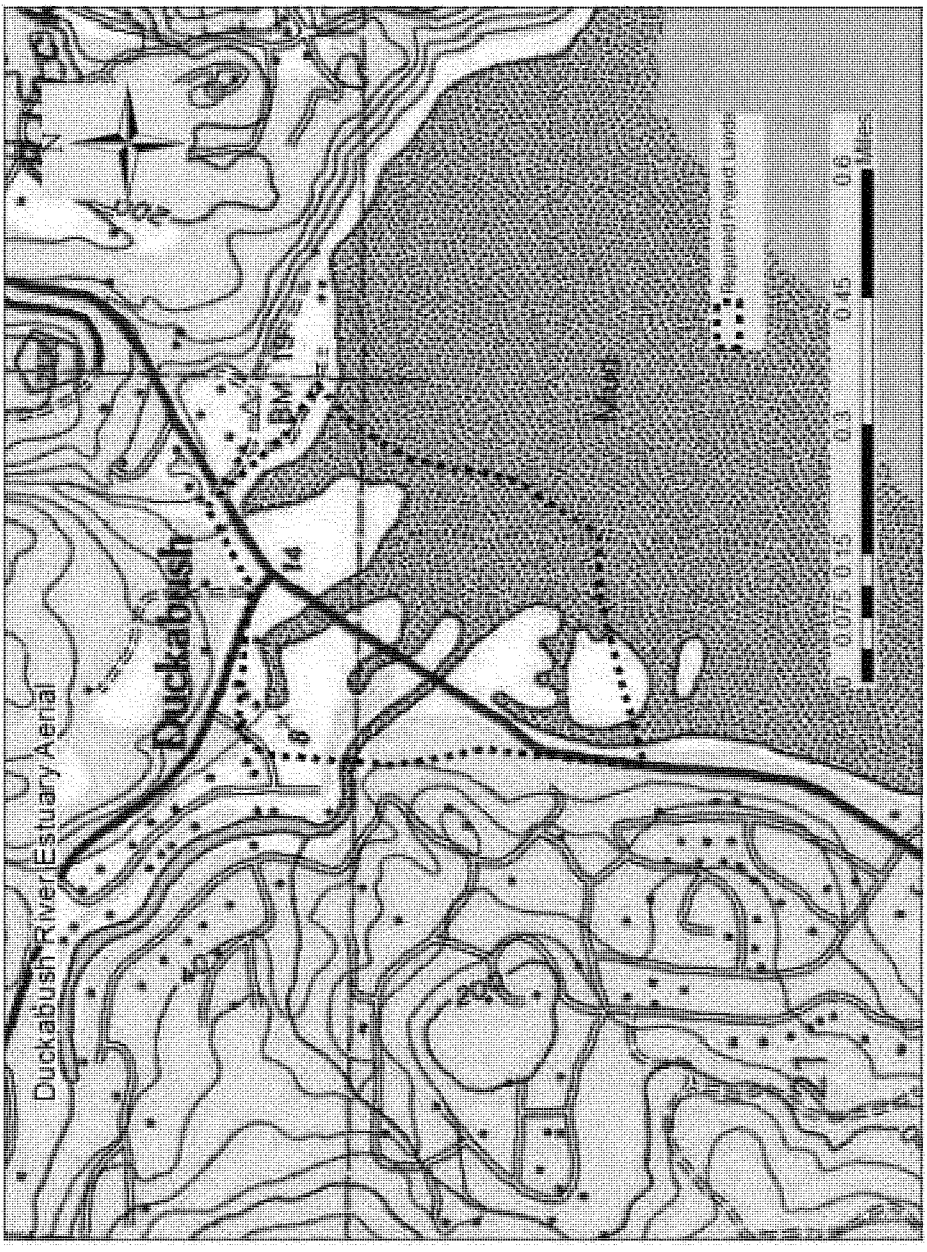
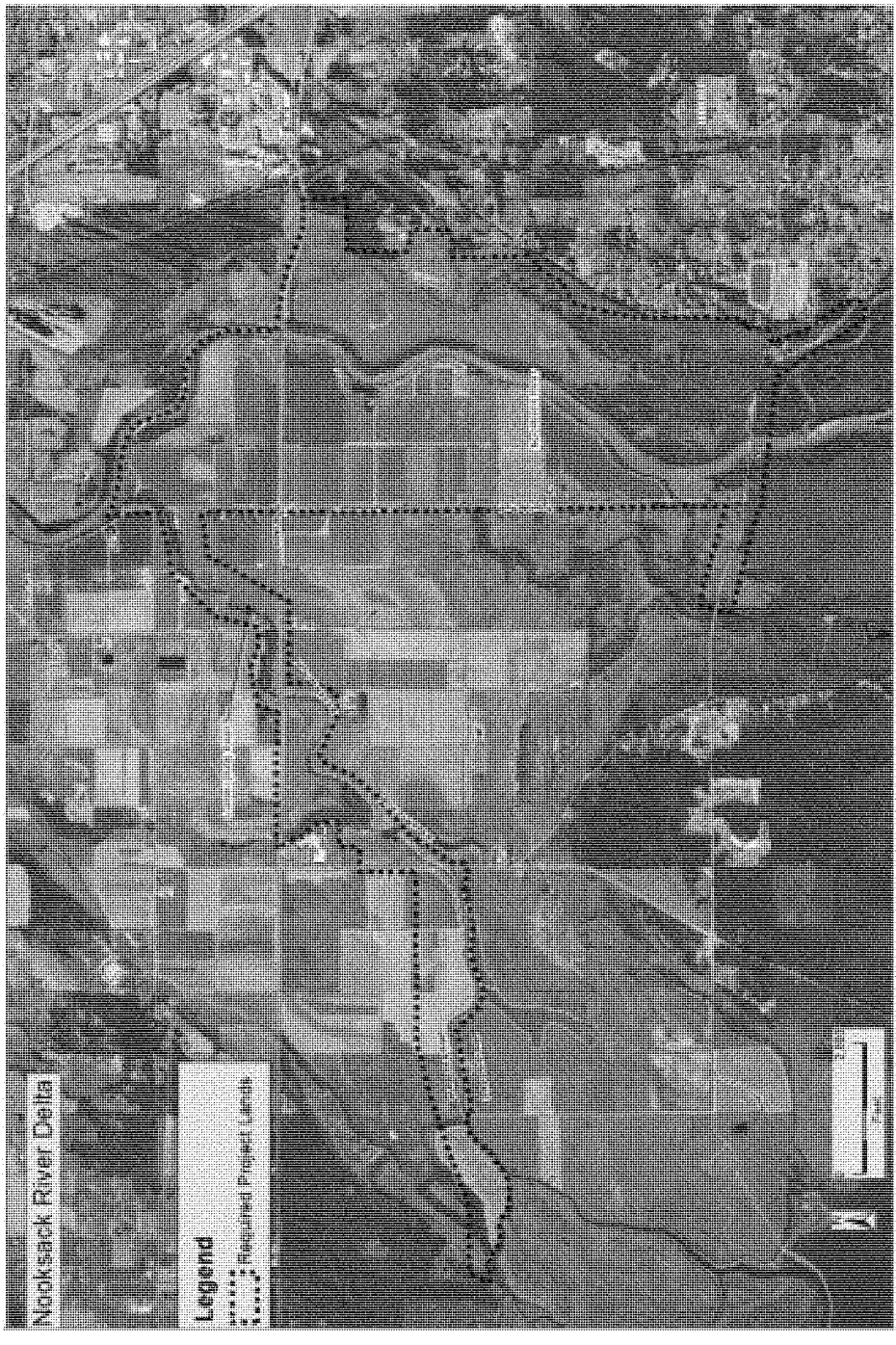
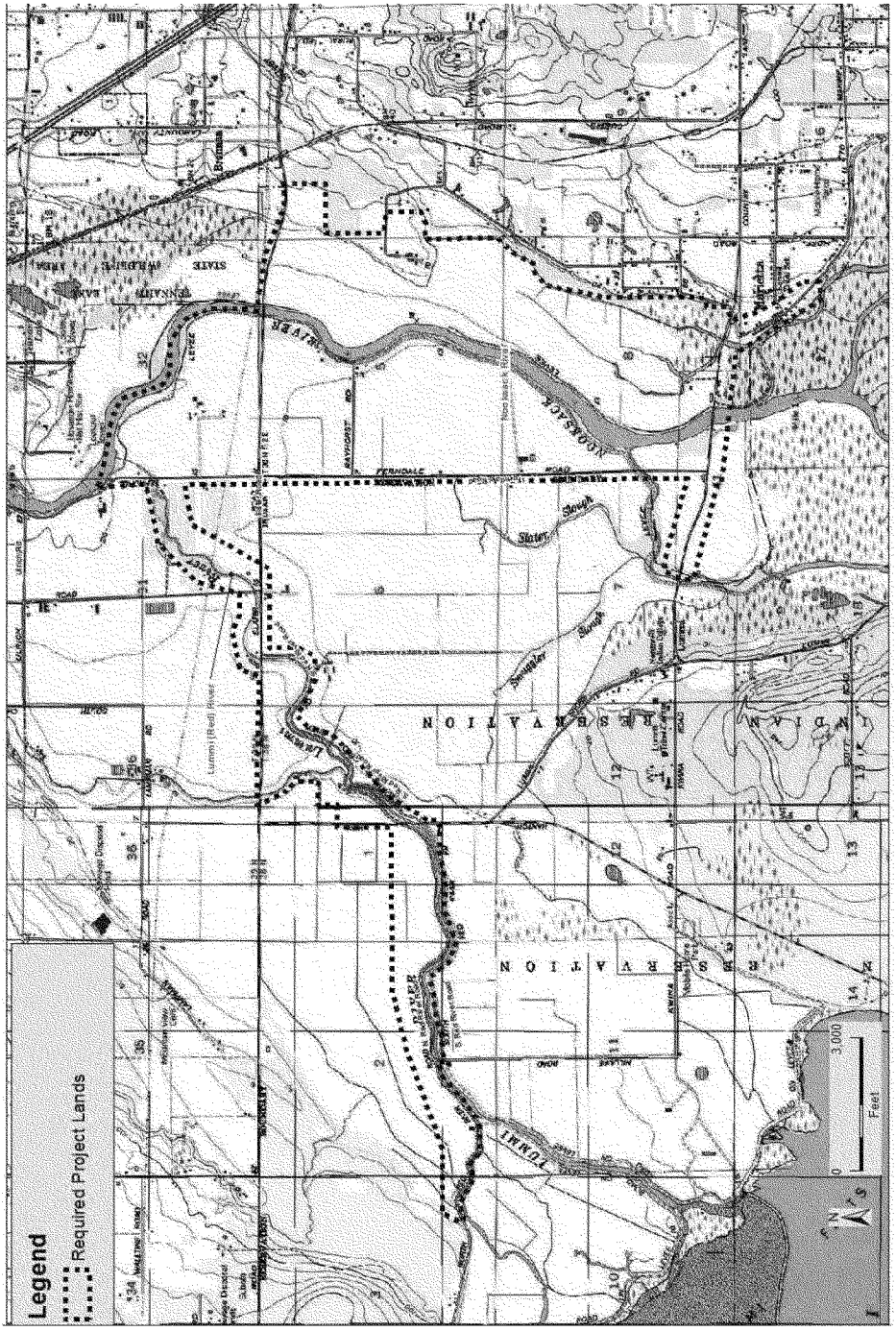
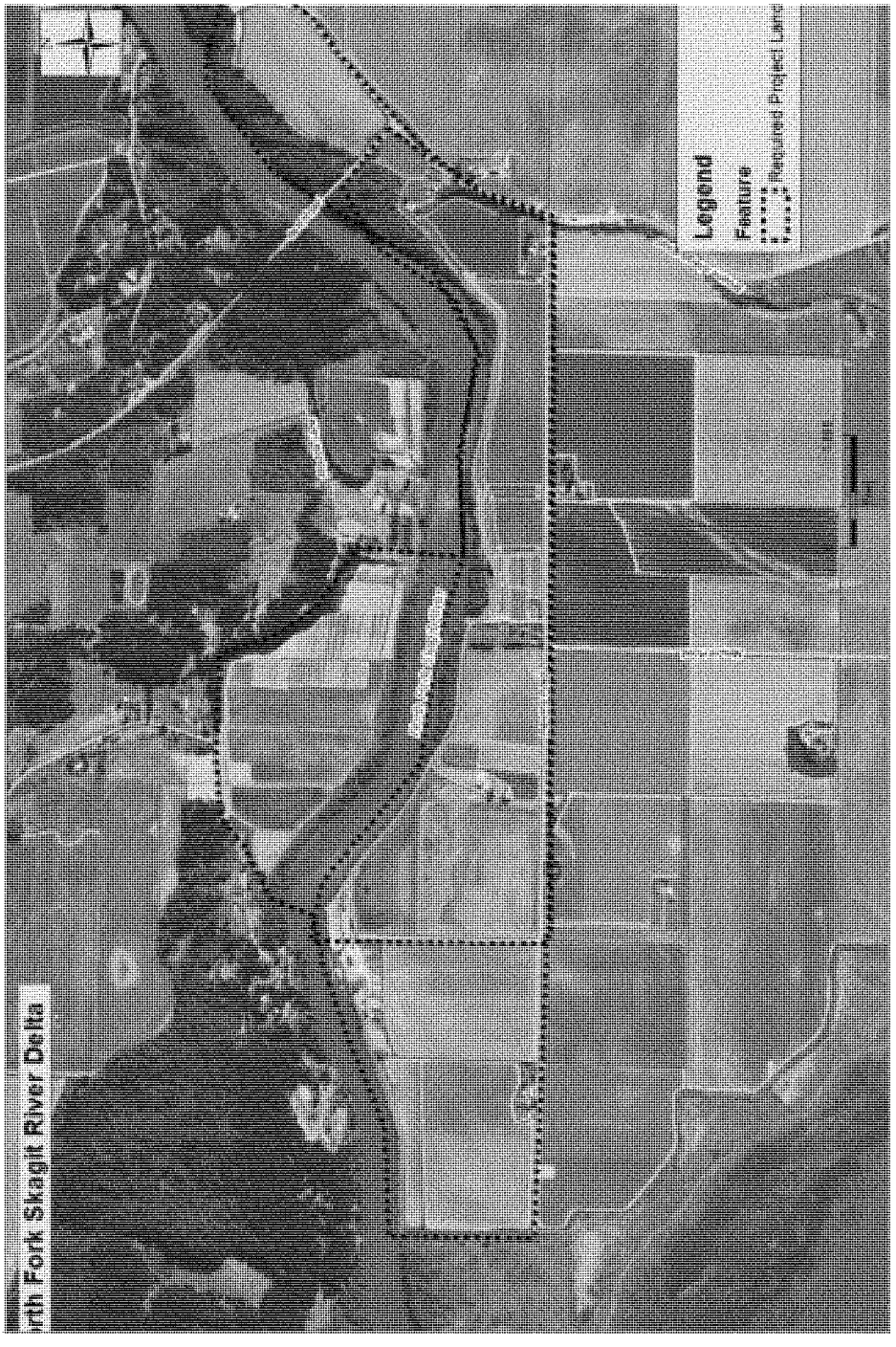
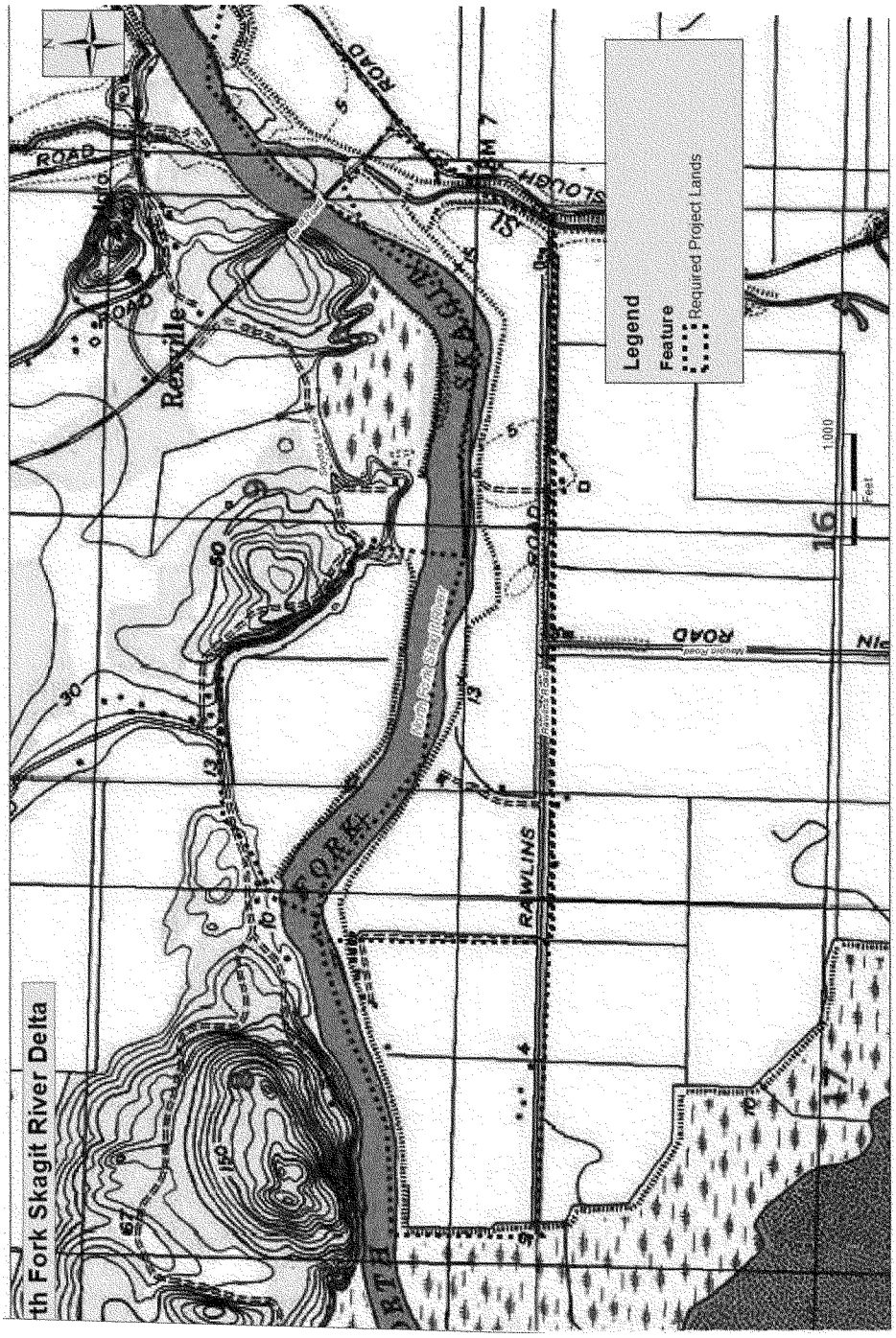
Miles


Duckabush River Estuary Aerial
Duckabush
Duckabush River
0 0.075 0.15 0.3 0.45 0.6 Miles


Nooksack River Delta
Legend
Required Project Lands


Legend
Required Project Lands
RESERVATION
RESERVATION
INDIAN
Lummi (Reil) River
NOOKSACK
FERNDALE
LUMMI
0
3,000
Feet
N


rth Fork Skagit River Delta
Legend
Feature
Required Project Lands


th Fork Skagit River Delta
Rexville
ROAD
SLOUGH
RAWLINS
ROAD
Legend
Feature
Required Project Lands
1,000
Feet

APPENDIX B
Interested Parties

Introduction
Because the PA covers three restoration areas located in three different counties within Washington State, not all of the signatories, invited signatories, and concurring parties have an interest in all three of the restoration sites. For example, the Lummi Nation is a Signatory to the PA due to the Nooksack River Delta restoration project extending onto Tribal lands; however, the Lummi Nation may not have an interest in either the North Fork Skagit River Delta or the Duckabush River Estuary restoration sites. Also, the Historic Bridge Foundation is a concurring party for their interest in the Duckabush Bridge at the Duckabush River Estuary site, but they may not have an interest in reviewing the Updated Levee Context Statement.

As such, the Corps has created a way for all consulting parties to opt-out of parts of the consultation. This would mean that if a party opts-out of a site or a feature, they would not be notified of any survey reports, context statements, field report, SHPO consultations, SHPO concurrences, and resolutions of adverse effects, UNLESS an issue arises that would require them to participate. Parties that have not opted out are deemed "interested parties".

Any party who opts-out can opt back in by notifying the Corps. The below list was compiled by contacting all the consulting parties in February 2016. This list can be updated by using Stipulation IV.A.2 of the PA.

Consulting Parties who have opted out of the Duckabush River Estuary Site:
- Jamestown S'Klallam Tribe
- Samish Indian Nation

Consulting Parties who have opted out of specific elements for the Duckabush River Estuary Site (i.e. Buildings, Bridges, Levees, Archaeology, etc.)
- None at this time

Consulting Parties who have opted out of the North Fork Skagit River Delta Site:
- Jamestown S'Klallam Tribe

Consulting Parties who have opted out of specific elements for the North Fork Skagit River Delta Site (i.e. Buildings, Bridges, Levees, Archaeology, etc.)
- None at this time

Consulting Parties who have opted out of the Nooksack Delta Site:
- Jamestown S'Klallam Tribe
- Samish Indian Nation

Consulting Parties who have opted out of specific elements for the Nooksack Delta Site (i.e. Buildings, Bridges, Levees, Archaeology, etc.)
- None at this time

APPENDIX C
Research Parameters

Introduction:
This section is intended to give research parameters for larger research questions and for the development of field methodologies for survey work contained within the PSNERP area. This appendix may be amended in accordance with Stipulation IV.A.2. (Amendments) of this Agreement.

I. Levee Context Statement:

A. The Corps will ensure work to revise and expand the historic context statement and registration requirements developed for levees by the USFWS in, *A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington, Task 2: Historic Context of Agricultural Dikes.*[6]

B. The Levee Historic Context shall be placed in the National Park Service Multiple Property Documentation (MPD) format as described in NPS Bulletin 16B. The revised context will address nineteenth and twentieth century periods of levee construction and identify appropriate historic periods of significance in Puget Sound with regard to settlement and development, commerce, agriculture, and flood protection. Specific attention will be given to the evolution of levee engineering to include private and public ventures, federal projects of the Depression era, the role of the Corps' various levee projects and repair efforts, and changes to the region's hydrology and landscape. Associated infrastructure and buildings such as pump houses and other levee related property types should also be addressed. Corps reports and maps on file at the Seattle District office will be consulted.

C. The updated levee report will be completed in advance of construction at any of the restoration sites. A draft document will be provided to SHPO and the signatories for review and comment. The Corps will submit the completed document to SHPO prior to the onset of construction, and in advance of any Section 106 consultations that might affect levees. Significance and integrity requirements for determining the National Register eligibility of levees will be based upon the findings of the updated historic context, and following established guidelines provided in *"Historic Structures Advisory #2: Flood Control Systems and Structures," Technical Center of Expertise, Preservation of Historic Structures and Buildings, U.S. Army Corps of Engineers, Seattle District.*

II. Development of Historic and Archaeological Context Statements: As defined by the National Park Service, "historic contexts are those patterns or trends in history by which a specific occurrence, property, or site is understood and its meaning (and ultimately its significance) within history or prehistory is made" (National Register Bulletin 1990). Historic contexts also aim to define property types, take stock of sites (known and projected), pose research questions, provide evaluation criteria, and discuss key bibliographic material. Historic and archaeological context statements should:

A. Identify regional historic trends in settlement and development and archaeological research questions.

B. Identify regional precontact themes and archaeological research questions.

C. Develop a field methodology appropriate to the level work to be done in the restoration sites.

D. The context statements will be completed in advance of construction at any of the restoration sites. A draft document will be provided to SHPO and THPO and the signatories for review and comment.

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[6] Sarah Stringer, Bowsher, Dan Killoren, Shannon Davis and Dave Iversen, *A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington, Task 2: Historic Context of Agricultural Dikes*, 2011.

III. Research Methodology: Archival research and survey activities should be designed to gather the information necessary to achieve defined preservation goals. Researchers must:

A. Be aware of, understand, and correctly employ those recognized research methods and techniques that are necessary to produce a credible scientific analysis, opinion, or conclusion;
B. Not commit an error of omission or commission that significantly affects an analysis, opinion, or conclusion;
C. Not make a series of errors that, considered individually, may not significantly affect the result of an analysis, opinion, or conclusion but which, when considered in the aggregate, establish that professional investigations are being rendered in a careless or negligent manner; and
D. Identify and consider the appropriate procedures and best practices required to perform the investigation.
E. Include in each written or oral report of communication concerning the results of the appraisal sufficient information to enable WDFW and the Corps to rely on the report or communication and to understand it properly, and must clearly and accurately disclose any extraordinary assumption or limiting condition that directly affects the analysis, opinion, or conclusion.
F. Communicate each analysis, opinion and conclusion resulting from investigations in a manner that is not misleading.
G. The research methodology will be completed in advance of construction at any of the restoration sites. A draft document will be provided to SHPO and THPO and the signatories for review and comment.

IV. Post-Review Discovery Plan: Prior to the construction phase, the Corps, in consultation with SHPO/THPO, WDFW, and interested parties, will develop a post-review discovery plan.

APPENDIX D

Previously Recorded Cultural Resource Sites for each Project Restoration Area

Introduction

The tables below contain previously recorded archaeological sites and built environment resources in and/or adjacent to the project footprints of the three restoration areas. The below information was obtained from a records search in the Washington Information System for Architectural and Archaeological Records Data (WISAARD). Once the Pre-Construction, Engineering and Design phase of the project begins additional research will be performed including a new record search in WISAARD, and other sources.

Table 1. Known archaeological sites located in the Nooksack River Delta, North Fork Skagit River Delta, and Duckabush Estuary proposed restoration sites.

Site Number*	Description	NRHP Eligibility	Location	Potential Effect to Resource Based on Current Design**
Nooksack River Delta Archaeological Sites				
45SH27	Pre-contact shell midden; Pre-Contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH170	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Unknown at this time
45WH526	Pre contact shell midden- possible village	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH723	Pre-contact shell midden; pre contact burial	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH734	Pre-contact lithic scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH742	Pre-contact isolate	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH847	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH848	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH862	Pre-contact shell midden; Historic trash scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH863	Pre-contact lithic scatter	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH896	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design

45WH907	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
45WH908	Pre-contact shell midden	Unevaluated	In project area	Appears that there will be no effect based on current project design
North Fork Skagit River Delta Archaeological Sites				
Fishtown Archaeological District 11	*Sqwikwikwab,* ethnohistoric village and historic town site	Eligible	Adjacent to project area	Appears that it will be affected based on current project design
45SK34	Pre-contact habitation site	Eligible: Part of the archaeological district (DT11)	Extends into project area	Appears that it will be affected based on current project design
45SK35	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
45SK78	Pre-contact shell midden site	Unevaluated	Just outside of project area	Appears that there will be no effect based on current project design
45SK80	Cave with pile of shell	Unevaluated	Adjacent to project area	Appears that there will be no effect based on current project design
45SK87	Pre-contact shell midden site	Unevaluated	In project area	Appears that it will be affected based on current project design
Duckabush Estuary Archaeological Sites				
45JE362	Duckabush Orchard	Unevaluated	In project area	Potentially effected

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

** Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change.

Table 2. Known built environment resources located in the Nooksack River Delta, North Fork Skagit River Delta, and Duckabush Estuary proposed restoration sites.

Description*	Date Constructed	NRHP Eligibility	Location	Potential Effect to Resource Based on Current Design**
Nooksack River Delta Structures				
Janet's House-1816 Bayon Road, Bellingham	1930-1950	Unevaluated-WISAARD states undetermined-SHPO	In project area	Appears that it will be affected based on current project design
Wylanoux House (Howell House)	1912	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Kwina Slough Levee	1927	Unevaluated	In project area	Appears that it will be affected based on current project design
Nooksack River Levee	1900, 1935, 1955	Unevaluated	In project area	Appears that it will be affected based on current project design

Lummi River Levee	1900	Unevaluated	In project area	Appears that it will be affected based on current project design
Jones House-1880 Marine Drive, Bellingham	ca. 2000	Not eligible	In side project area	No effect as house has been determined not eligible
1850 Shady Lane-Historic single family residence	1950	Unevaluated	On border of project area	Appears that there will be no effect based on current project design
Scarborough-1857 Marine Drive, Marietta	1920	Not Eligible	In project area	No effect as house has been determined not eligible
White-1853 Marine Drive, Marietta	1915	Not Eligible	In project area	No effect as house has been determined not eligible
Maricttа/Custer Grange Hall	1920	Eligible	Just outside project area	Appears that there will be no effect based on current project design
1835 Marine Drive-Historic single family residence	1925	Not Eligible	In project area	No effect as house has been determined not eligible
1801 Marine Drive Historic single family residence	1949	Not Eligible	In project area	No effect as house has been determined not eligible
WH207-Boundary marker	1861	Listed on NRHP	In project area	Appears that there will be no effect based on current project design
North Fork Skagit River Delta Structures				
North Fork Skagit River Levee	1935	Not Evaluated	In project area	Appears that it will be affected based on current project design
45SK337	Sumners Farm Barn 1885	Washington Heritage Barn Register (WHBR)	In project area	Appears that it will be affected based on current project design
Duckabush Estuary Structures				
Duckabush River Bridge	1934	Listed on NRHP	In project area	Adverse effect with proposed removal
Northern Distributary Channel Bridge	1934	Unevaluated	In project area	Adverse effect with proposed removal

*Location of sites is based on information from the DAHP database and site form data. Note existing site boundaries have not been field verified for this project.

** Project designs could change in PED. The effect or lack of effect to the resources is based on the current information to date and is subject to change if project designs change

APPENDIX E

Treatment Measures for Mitigation of Adverse Effects

Introduction

If historic properties are found within with the area of potential effects (APE) for the Nooksack River Delta, North Fork Skagit River Delta, and the Duckabush River Estuary restoration sites, the Corps, in consultation with interested parties (see definition in Stipulation I.A. Applicability), will assess adverse effects to the historic properties in accordance with 36 CFR 800.5(a)(1). Should adverse effects be identified, the Corps in coordination with interested parties will resolve the adverse effect following Stipulation II.A.5.c.3. The Corps will first attempt to resolve adverse effects to a historic property by determining if avoidance of the historic property is feasible through redesign of the project and/or specific project elements that areas causing the adverse effect. If avoidance is not possible, the Corps then will look for ways to minimize the adverse effect to a historic property. Minimizing the adverse effect could include shifting specific project elements away from the historic property to lessen the adverse effect. Avoidance and minimization of adverse effects will be dependent on the type of historic property (archaeological site vs. historic structure) and the type of adverse effect (i.e. construction related, visual, noise, etc.). Should avoidance or minimization of adverse effect not be feasible or if the adverse effect is unavoidable and determined to be in the best interest of the public, the following treatment measures outlined below are suggested for the resolution of adverse effects.

Because adverse effects cannot be determined at this point in time, the below treatment measures are written in such a way to allow flexibility to appropriately mitigate adverse effects that may occur to historic properties at each of the three restoration locations. One or more of the following Treatment Measures may be appropriate, depending on the nature of historic properties affected and the severity of adverse effects. In addition, the resolution of adverse effect(s) is highly dependent on the type of historic property, and the type(s) of adverse effect(s). The term "designated responsible party" is used below and refers to either the Corps or WDFW who will be responsible for overseeing the successful implementation of the treatment measures.

As this PA is executed for a 20-year duration, it is possible that new treatment measures may become available as the field of cultural resources continues. If new practices or ideas for resolving adverse effects become available and are desired to be used by interested parties, this Appendix may be amended in accordance with Stipulation IV.A.2. of this Agreement, Amendments.

I. **Public Interpretation:** The designated responsible party will work with the SHPO/THPO and interested parties to develop an educational interpretive plan. The plan may include signs, displays, educational pamphlets, websites, articles, lectures, workshops, new and emerging technologies and other similar mechanisms to educate the public about historic properties within the local community, state, or region. Once an interpretive plan has been agreed upon by the interested parties, SHPO/THPO, and the designated responsible party will continue to consult throughout implementation of the plan until all agreed upon actions have been completed by the designated responsible party.

II. **Historic Context Statements and Narratives:**

A. This treatment measure differs from the Levee Context statements and Historic and Archaeological context statements that are discussed in the PA. Those context statements are intended to help guide the field work.
B. These Historic Context Statements and Narratives are to be used for mitigation. This treatment measure will focus on an individual property or site, a historic or archaeological district, a set of

related properties or sites, relevant themes as identified in the statewide preservation plan and/or research questions generated for this project.

C. Prior to project construction, the designated responsible party will work with the SHPO and Interested Parties to determine the topic and framework of a historic context statement or narrative the designated responsible party shall be responsible for completing.
D. Any context statements shall be placed in the National Park Service Multiple Property Documentation (MPD) format as described in NPS Bulletin 16B.
E. Once the topic of the historic context statement or narrative has been agreed upon, the designated responsible party shall continue to coordinate with the SHPO and Interested Parties through the drafting of the document and delivery of a final product. The Corps shall have final approval on the quality of the documentation provided by the designated responsible party. The designated responsible party will use staff or contractors that meet the Professional Qualifications for the appropriate discipline.

III. Oral History Documentation: Prior to project construction the designated responsible party will work with the SHPO/THPO and Interested Parties to identify oral history documentation needs and agree upon a topic and list of interview candidates. Oral history documentation can focus on a wide range of topics including but not limited to: local communities' connection to the restoration area, settlement/development of the area; collection of recollections/memories of elders/community members'/landowners regarding past events that occurred within the restoration area. Once the parameters of the oral history project have been agreed upon, the designated responsible party shall continue to coordinate with the SHPO and Interested Parties through the data collection, drafting of the document, and delivery of a final product. The SHPO/THPO and the Corps shall have final approval on the quality of the documentation provided by the designated responsible party. The designated responsible party will use staff or contractors that meet the Professional Qualifications for the appropriate discipline.

IV. Structural and Archaeological Site Inventory:

A. This treatment measure differs from the historic and archaeological site fieldwork that will occur prior to construction.
B. Historic and Archaeological Site inventory to be used as treatment measures for mitigation purposes where efforts may be directed toward the re-survey of previously recorded historic and archaeological sites, designated historic properties and/or districts which have undergone change or lack sufficient documentation, or the survey of new historic properties and/or districts that lack formal designation.
C. This could be for historic properties that are located within the APEs but would not be affected by the Undertaking; for historic properties and/or districts that may extend into or be located on the boundary of the APEs.
D. Prior to project construction, designated party will work with the SHPO/THPO and participating parties to establish the appropriate level of effort to accomplish a historic or archaeological site inventory.
E. Once the boundaries of the survey area have been agreed upon, the designated responsible party shall continue to coordinate with the SHPO/THPO and participating parties through the data collection process.
F. The designated responsible party will use SHPO/THPO standards for the survey of historic properties and SHPO/THPO forms as appropriate.
G. The designated responsible party will prepare a draft inventory report, according to SHPO/THPO templates and guidelines, and work with the SHPO/THPO until a final property inventory is approved. The designated responsible party will use staff or contractors that meet the Secretary's Professional Qualifications for the appropriate discipline.

V. Archaeological Data Recovery

A. Prior to project construction, the designated responsible party will work with the SHPO/THPO and interested participating parties on an archaeological data recovery plan for archaeological sites where it has been determined that data recovery is the appropriate mitigation for the resolution of adverse effects to the historic property.

B. Data recovery will be used to recover important information that would be lost as a result of the project and/or project elements.

C. The data recovery plan will include (but is not limited to):
   1. Discussion of the National Register significance of the property.
   2. Research questions that are directly pertinent to the Historic Property undergoing data recovery.
   3. Results of previous research relevant to the site.
   4. Background research relevant to the site (geological, prehistory, history, etc.).
   5. Proposed field methodology and techniques.
   6. Proposed artifact collection methodology.
   7. Proposed laboratory processing and analysis.
   8. Methods and techniques used in artifact, data, and other records management.
   9. Artifact curation during the Federal interest of the project and how artifacts will be returned to land owners after the Federal interest of the project is over.
   10. Plan for public outreach as part of the data recovery and/or results from the data recovery.

D. Each data recovery plan will be tailored to the specific site undergoing data recovery.

E. A draft data recovery plan will be reviewed by SHPO/THPO, WDFW and all interested parties prior to being finalized.

F. The SHPO/THPO and the Corps shall have final approval on the quality of the data recovery plan provided by the designated responsible party.

VI. Geo-References of Historic Maps and Aerial Photographs:

A. Prior to project construction, the designated responsible party will work with the SHPO/THPO and interested participating parties to identify the historic maps and/or aerial photographs for scanning and geo-referencing.

B. Once a list of maps and/or aerial photographs have been agreed upon, the designated responsible party shall continue to coordinate with the SHPO and interested participating parties through the scanning and geo-referencing process and shall submit drafts of paper maps and electronic files to them for review.

C. The SHPO/THPO and the Corps shall have final approval on the quality of the documentation provided by the designated responsible party. The final deliverable shall include a paper copy of each scanned image, a geo-referenced copy of each scanned image, and the metadata relating to both the original creation of the paper maps and the digitization process.

VII. Design Review by SHPO/THPO and Interested Parties: Prior to project construction, the Corps and WDFW shall work with the SHPO/THPO and interested parties to develop a design that preserves and protects historic values. Plans and specifications will, to the greatest extent feasible, preserve the basic character of the affected historic property. Primary emphasis shall be given to significant view sheds, and significant character-defining features (e.g. design, massing, cladding, windows, doors, porches) that will be repaired or replaced with either in-kind materials or materials that approximate the originals in appearance. Aesthetic camouflaging treatments such as use of veneers, paints, texture compounds and other surface treatments and/or use of sympathetic infill panels and landscaping features will be employed to the greatest extent feasible. Final construction

drawings used in the bidding process will be submitted to the SHPO/THPO for review and comment prior to the award of a construction contract and the initiation of construction activities.

VIII. Marketing Plan for Relocation: Prior to project construction, the Corps and WDFW shall work with the SHPO/THPO and interested parties will make a good faith and reasonable effort to identify a party or parties willing to purchase and relocate the historic structure(s). A good faith and reasonable effort should include publicizing and advertising the property in newspapers, magazines, and/or websites of record for a specific period of time. The purchaser must be willing to use a professional structures mover that follows the recommendations in Moving Historic Buildings by John Obed Curtis (1975, Reprinted 1991 by W. Patram for the International Association of Structural Movers) or other similar updated brochure. This marketing plan will be used in conjunction with Treatment Measure X., Recordation Package. If the good faith and reasonable effort does not result in the identification of a party or parties willing to relocate the property, the property may be demolished following the completion of the recordation package. Timeframes and specifics regarding this marketing plan will be developed in the consultation package to SHPO/THPO.

IX. Salvage: Prior to project construction, elements of the affected structure shall be offered for salvage to a responsible party, at the salvaging party's expense. The salvaged elements may be re-used in new construction, rehabilitation of existing structures, or in displays for educational purposes. Additionally, the activities shall not occur at or below grade in order to avoid affecting unevaluated archaeological resources. The salvage treatment measure will be used in conjunction with Treatment Measure X., Recordation Package. Timeframes and specifics regarding the salvage will be developed in the consultation package to SHPO/THPO.

X. Recordation Package: This treatment measure provides documentation of either the subject property or other properties as agreed upon by the interested parties. Prior to project construction, the designated responsible party shall oversee the successful delivery of the recordation package prepared by staff or contractors that meet the Professional Qualifications for Architectural History, History, Architecture, or Historic Architecture, as appropriate.

A. DAHP Mitigation Options and Documentation Standards, 2010 or subsequent revisions, will be used. These requirements are outlined at http://www.dahp.wa.gov/sites/default/files/MitigationDocumentationStandards.pdf
B. These documentation standards are tiered from Level I, II, and III. Interested parties will agree to a level appropriate and commensurate with the level of adverse effect.
C. The designated responsible party will submit the recordation package to the SHPO and interested parties for review. Once accepted by SHPO, the designated responsible party will notify the interested parties of the submission.

XI. Photography of Collections: This treatment measure may be appropriate for the following circumstances including but not limited to: private collection(s) held by local landowners consisting of artifacts the landowner found on their land that is located in the project footprint, a collection held in museums that were recovered from project lands in the past.

A. Prior to project construction the designated responsible party shall submit the collection photograph package digitally to the Corps for review and approval. Once approved by the Corps, the designated responsible party shall submit full copies of the approved Digital Photography Package to an identified repository(ies) for permanent retention. Repositories will be identified on a case-by-case basis and may include the SHPO, the Washington State Archives, local museums or historical societies. Photographs shall be taken in accordance with curation standards and the

package will include both digital photographs and copies printed on archival paper. The repository shall dictate any additional requirements such as file type (TIFF, JPEG).

B. The package shall also include a narrative describing the collection. At a minimum the narrative should include a description of the collection contents; how the collection was obtained, and the ability of the collection to inform about past use and occupation of area.

APPENDIX F
List of Contacts

Introduction
As per Stipulation I.B.5., every party included in this PA will provide their contact information to ensure timely coordination and correspondence. This list should include all the relevant information for those who want to be notified of Undertaking addressed in this PA. This list will be updated as-needed using Stipulation IV.A.2., and shared with all parties as part of the quarterly reports, or on an as-needed basis.

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Advisory Council on Historic Preservation

Lummi Nation

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Lower Elwha Klallam

Muckleshoot Tribe of Indians

Nisqually Indian Tribe

Nooksack Indian Tribe

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Samish Indian Nation

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City of Bellingham Planning Division

Jefferson County Historical Society

Jefferson County Planning Department

National Trust for Historic Preservation

Quilcene Museum

Skagit County Historical Museum

Town of La Conner

Washington Trust for Historic Preservation
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Executive Director
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Whatcom County Historical Societ

Preserving America's Heritage

June 15, 2016

Mr. Evan Lewis
U.S. Army Corps of Engineers
Chief, Cultural Resources Section
Environmental and Cultural Resources Branch
Seattle District Section
P. O. Box 3755
Seattle, Washington 98124-3755

Ref: *Puget Sound Nearshore Ecosystem Restoration Project*

Dear Mr. Lewis:

Enclosed is your copy of the fully executed Programmatic Agreement (Agreement) for the referenced project. By carrying out the terms of the Agreement, you will fulfill your responsibilities under Section 106 of the National Historic Preservation Act and the regulations of Advisory Council on Historic Preservation. The original Agreement will remain on file at our office.

We commend the U.S. Corps of Engineers for working closely with the Lummi Nation, the Washington State Historic Preservation Office, the Washington Department of Fish and Wildlife, the Washington State Department of Transportation toward implementing Section 106 of the National Historic Preservation Act (NHPA) for this undertaking.

If we may be of further assistance as the Agreement is implemented, please contact Brian Lusher of our staff at 202-517-0221 or via e-mail at blusher@achp.gov.

Sincerely,

Tom McCulloch, Ph.D., R.P.A.
Assistant Director
Office of Federal Agency Programs
Federal Property Management Section

Enclosure

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX E

MONITORING AND ADAPTIVE MANAGEMENT

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps of Engineers
Seattle District

Puget Sound Nearshore Ecosystem Restoration Project

Monitoring and Adaptive Management Plan

June 2016

The following three site-specific monitoring plans describe the monitoring metrics, performance targets, and adaptive management measures to be applied at each of the sites of the recommended plan, which is detailed in the Final Feasibility Report and Environmental Impact Statement. The general Monitoring Framework that was developed during feasibility phase forms the basis for development of the monitoring metrics and follows the site-specific plans for reference. The three restoration sites of the recommended plan are as follows:

- North Fork Skagit River Delta
- Nooksack River Delta
- Duckabush River Estuary

North Fork Skagit River Delta

1 Project Monitoring Objectives: North Fork Skagit River Delta

As a restoration project, it is expected that this site will be dynamic and evolve. Thus, for some parameters, strict achievement of predetermined performance standards will not necessarily predict the success or reveal the failure of the restoration effort. The monitoring and evaluation will focus on determining whether the overall project objectives of the restoration are being met. Monitoring efforts will be performed by using monitoring metrics. All post-construction monitoring will be performed by qualified biologists and hydraulic engineers.

Evaluating the success of the restoration site will be based on the establishment of the targeted habitat within the restoration site and on the ecological functioning of those habitats. All post-construction monitoring will be cost shared between the Corps and the non-Federal sponsors for the first 10 years of monitoring. The non-Federal sponsors may choose to monitor beyond this 10-year period, although the cost would be 100% their responsibility. Data collection will be used to determine success of the project with the focus on the development of estuarine and freshwater tidal wetlands and vegetated riparian zone. Restored wetlands can take decades to reach their dynamic equilibrium conditions, therefore the initial monitoring period of approximately 10 years will be assessed as to whether the structural template has been established and if the site is on a trajectory toward ecological success (Haltiner et al. 1997). The Corps and the non-Federal sponsors will use the knowledge gained through this monitoring to adaptively manage the project sites.

The following site-specific objectives have been identified for restoration at the North Fork Skagit River Delta:

1. Reconnect and restore lost floodplain habitats including channel meander zone, shoreline complexity, and shaded refuge habitat.
2. Reconnect and restore lost tidally influenced area including estuarine and freshwater tidal wetlands and tidal channels in the North Fork Skagit River Delta.
3. Re-establish foraging habitat for Great Blue Herons, and improve resting and foraging tidal flat habitats for large flocks of waterfowl migratory shorebirds of the Pacific Flyway.
4. Improve aquatic habitat connectivity between lower river systems and upstream habitat networks.
5. Restore a more natural riparian corridor along the North Fork Skagit River Delta.

These objectives are expected to achieve three different habitat types across the restoration site: saltmarsh wetlands at the downstream end and lower elevations, a scrub-shrub wetland ecotone across most of the site given the existing and anticipated elevations, and a vegetated riparian buffer zone. The excavated tidal channels will intersect all three of these habitat zones. The site is expected to support a dynamic habitat mosaic as it reaches an equilibrium of restored interactive processes.

Section 3 lists monitoring metrics, performance targets, and potential adaptive management associated with the effectiveness monitoring, which aims to measure how well the habitat is developing according to performance criteria.

2 Reference Site

The reference site selected for the North Fork Skagit River project site is the reach of river that begins immediately adjacent to the downstream end of the project site (Figure 1). This reach is not considered to necessarily be in "historical condition" because upstream activities such as dams and farming over the past century have likely altered conditions that existed prior to these manipulations (Hood 2009). However, the reach has natural processes of sediment erosion and deposition, sustained tidal channels, as well as intact tidal inundation to sustain wetlands and is therefore a sufficient reference target for restoration of natural processes and ecosystem functions. The reference reach curves northward before turning west again to enter Puget Sound. The reach is approximately 2 miles long, and the left bank is mostly vegetated with no evidence of direct human interference. The right bank has a short modified reach but is otherwise natural. The channel width varies from 350 to 550 feet wide, which is roughly the same as the project site. The reference site is in the scrub-shrub zone and contains substantial native vegetation that can serve as a seed source as tidal inundation is restored to the project site, which will also be within the tidal elevations of the scrub-shrub zone once restored. The reference site contains all of the expected types of riverbank complexity features for this type of site including but not limited to shrubs, trees, accumulations of woody debris, varying substrate sizes, and erosional and depositional reaches. This reference site applies to all of the monitoring metrics listed in Section 3.

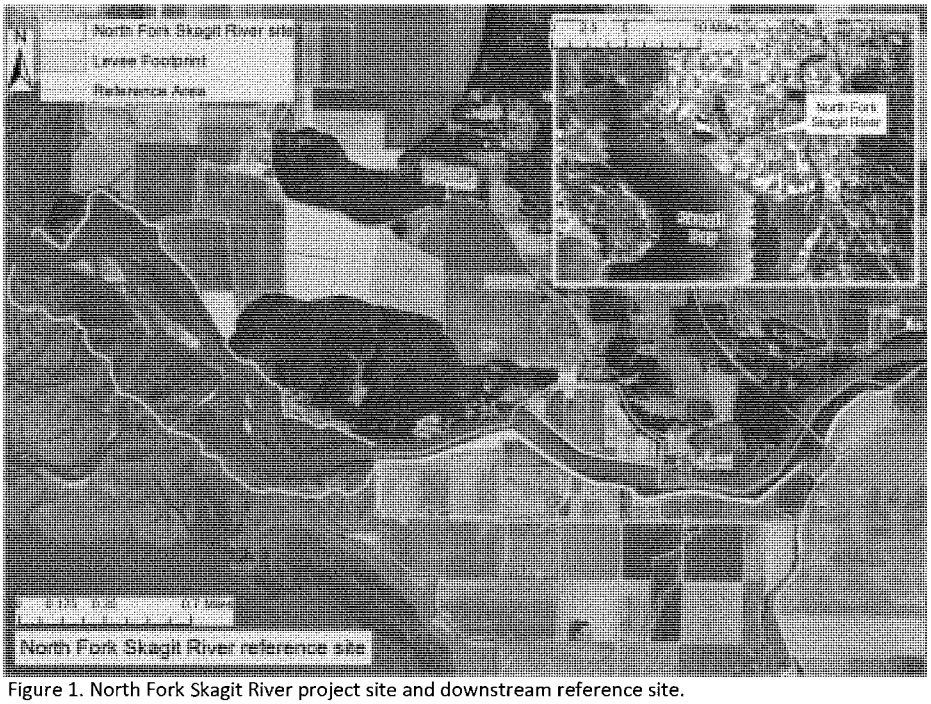

Figure 1. North Fork Skagit River project site and downstream reference site.

3 Monitoring Metrics, Targets, and Adaptive Management Measures

All of the following metrics, methods, targets, and adaptive management measures may be adjusted during pre-construction, engineering, and design (PED) phase as surveys, hydraulic modeling, and detailed designs are completed.

3.1 Monitoring Metric 1: Increased tidal prism of water reaching a reconnected floodplain (Objectives 1-4)

Methods and Timing: Existing conditions were determined through LiDAR and established NOAA tide stations; however, this method does not provide data with the local accuracy required for post-construction monitoring and adaptive management. To determine whether the site is reaching the performance target stated below, a water surface gauge or pressure sensing data logger will be installed on the left bank of North Fork Skagit River near the midpoint of the site. This sensor will be used to measure the tidal and riverine elevations and to quantify frequency, duration, and area of tidal inundation (Roegner et al. 2009). When combined with NOAA gauge No. 9448558 at La Conner ,WA and coastal hydraulic modeling, a single water surface sensor is sufficient to characterize the tidal elevations in the vicinity of the project as well as at the reference site. The sensor will be checked every 3-6 months. The data will be used to estimate intertidal prism parameters such as areas of highest and lowest tidal inundation and to calculate the volumetric difference between high tide and low tide. Morphological feature extents in the landscape profile (channels, hummocks) will be noted. The complete dataset will be analyzed once per year in years 1, 2, 6, and 10 after construction to verify project success of providing tidal influence to the site (Neckles et al. 2002). The greatest change will occur in the first two years. Subsequent measurements every 4 years will quantify additional change toward site conditions that may not be stabilized until 20 or more years post-construction. This duration of monitoring will allow sufficient time for higher high tides and significant floods to exert influence over the substrate materials and excavated channels. The predicted response, as shown in Table 4-1 of the Monitoring Framework, is that the period of inundation will increase as tidal hydrology is restored, then will decrease as the marsh elevation increases. By 10 years post-construction, data will show the trajectory of site development and decisions can be made regarding whether contingency measures are required. Site topography data would be collected via remote sensing and on-the-ground survey making opportunistic use of other LiDAR efforts in the Puget Sound area.

If a flood level greater than a 2% Annual Exceedance Probability occurs within the first 15 years after construction, then the site should undergo an additional monitoring assessment. Any monitoring after 10 years post-construction is at 100% cost of the non-federal sponsor.

Performance Target: The performance target is to achieve inundation of the newly constructed channels for at least 40% of the tidal cycle by 10 years after construction.

Adaptive Management: If the site has not reached its performance target by 10 years after construction, then additional removal of material where the levees stood may be needed, and/or more excavation at the breaches and/or along the channel excavations may be necessary. All site data should be integrated for a thorough analysis of conditions before additional construction actions are taken.

3.2 Monitoring Metric 2: Wetland development (Objectives 2 and 3)

Methods and timing: Three levees will be removed during construction. The acreage of the footprints of these levees is 29 acres for the main left bank area, 5 acres for the small left bank area upstream of Best Road Bridge, and 5 acres for the right bank area (see Figure 1). The footprint is considered to be all of the area excavated to remove each of the three levees, which would become bare soil on the site. This footprint of each levee removal area will be monitored to ensure the restored area is developing wetland characteristics. This is the critical area of disturbed soils that must be monitored. Planting the entire 256-acre site would not likely be cost-effective and passive colonization has been determined to be a successful strategy for estuarine marshes (Hood 2009). Wetland reconnaissance site visits will be conducted to document the presence/absence of hydric soils, hydrophytic vegetation, and wetland hydrology using the methods in the *USACE Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE 2010). Monitoring site visits will occur in years 2, 3, 6, and 10.

Performance Target: The target is for at least 80% of each levee removal footprint (23 acres of main left bank, 4 acres of small left bank area, and 4 acres of right bank area) to function as wetland. If early monitoring results show that the site is not on a trajectory to achieve the target, implementation of adaptive management measures should be evaluated to determine whether the trade-off is worth the site disturbance as implementation would likely destroy some plantings.

Adaptive Management: If the target is not met, then additional removal of material where the levees stood and/or more excavation at the breaches may be necessary, but no more than 10% of initial construction quantities. The area would need to be analyzed for whether it can be manipulated to create hydrological conditions to support wetland soils and plants, and sampling could move outside of the footprint of the levee removal area for further investigation. The area should also be analyzed for whether it is providing equivalent functional value of a different habitat type to the performance target before undertaking any construction measures to meet the previously stated performance target.

3.3 Monitoring Metric 3: Increased area of soil salinity gradient (Objectives 1-4)

Methods and Timing: For each of the three discrete areas of the restored site, sample soil salinity during low tide at various ground elevations along transects across the site. Sampling timing will be focused on plant growing seasons and location will be focused on critical rooting depths.

Performance Target: The performance target for the restoration area that is at or below mean tide level is to have soil salinity levels within the range of at least 5-15 parts per thousand (ppt) to assist with saltmarsh development. This parameter will be monitored in years 2, 3, 6, and 10 after construction to verify project success of providing tidal influence to the site for the expansion of salt marsh habitat. This sampling will be combined with other metrics to follow the same transects. This duration of monitoring will allow sufficient time for higher high tides to exert influence over the substrate materials and excavated channels.

Adaptive Management: If the target of reaching the range of soil salinity levels is not achieved, then additional removal of material where the levees stood may be needed, and/or more excavation at the breaches may be necessary to meet the tidal exchange and salinity levels for saltmarsh establishment.

3.4 Monitoring Metric 4: Density of native woody species (Objectives 1, 2, and 5)

Methods and timing: Measure plant stem density along established transects of all planted areas during the late summer when seasonal vegetative growth is at its fullest. Post-construction monitoring is recommended to occur in year 3, since the contractor will be responsible for 100% survival of planted vegetation for the first year.

Performance Target: Native woody species (planted and volunteer) will achieve an average stem density of at least 80% of the installed plant density in all planted areas of the site by year 3. Installed plant density is projected to be 32 shrubs per 1,000 square feet (planted 6 feet on center) and 5 trees per 1,000 square feet (planted 15 feet on center). Thus, the 80% performance target density would be 26 shrubs and 4 trees per 1,000 square feet. This target density will be represented by native Puget Sound lowlands species. Trees and shrubs typically found in the Puget Sound lowlands may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)
- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Adaptive Management: If the above target is not met, then additional plantings would be installed. If survival of certain species from the original planting plan is low, changes in species planted may be necessary. Additional irrigation of plants may need to be provided if they appear to have been water stressed during the first three years.

The local sponsor will monitor for invasive species; this must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. Invasive species shall not exceed 10% of the total plant coverage on the site. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

3.5 Monitoring Metric 5: Aerial coverage of native woody vegetation (Objectives 1, 2, 4, and 5)

Methods and Timing: Measure percent aerial cover along established transects of all planted areas during late summer when seasonal vegetative growth is at its fullest. Aerial cover is the percentage of the ground surface covered by the aerial portions (leaves and stems) of a plant species when viewed from above. The surveyed area should include all ground disturbed by construction, and all planting areas at a minimum. Post-construction monitoring is recommended to occur in years 3, 6, and 15. Years 6 and 15 are included to provide a reasonable amount of time for shrubs to reach maturity and trees to reach the height that provides a strong chance of survival so the Corps can determine whether sufficient cover has been achieved or whether an adaptive management measure must be implemented. Any monitoring that occurs after year 10 will be 100% cost of the non-Federal sponsor.

Performance Target: It is expected that coverage will increase as planted and volunteer species grow. Planted and native volunteer trees and shrubs should be healthy and have a high percentage of aerial

coverage. Trees and shrubs typically found in the Puget Sound lowlands may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)
- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Performance targets include the following:

- Year 3: at least 30% aerial cover of native shrub and/or tree species
- Year 6: at least 60% aerial cover of native shrub and/or tree species
- Year 15: at least 80% aerial cover of native shrub and/or tree species

Adaptive Management: If the above targets are not met, then additional plantings would be installed and/or changes in species planted from original planting plan if survival of certain species is low. Additional irrigation of plants may needed if they appear to be water stressed during the first 3 years.

The local sponsor will monitor for invasive species; this for invasive species must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

4 Contingency Planning and Implementation

Contingency measures (adaptive management) will be implemented if the monitoring program indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-Federal sponsor would then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. Monitoring and adaptive management activities in this plan will be refined in preconstruction, engineering, and design phase. Additional metrics, methods, performance targets, and adaptive management measures may be added if needs are identified.

The general timeline for meeting performance targets is 6-10 years after construction. This is estimated to be sufficient time to determine ecological success or at least a site's trajectory toward success through measurement of the physical and biological parameters outlined in this monitoring and adaptive management plan. Many metrics require sampling through at least year 6 post-construction. The Corps and non-Federal sponsor should analyze all data collected to this point and make an assessment as to whether ecological success has been achieved, or if the site is on a trajectory predicted to achieve success. An assessment can be made as to whether the monitoring should continue through year 10. If monitoring continues through year 10, it is at this point that the project partners should make an assessment as to whether any of the adaptive management measures should be implemented as a contingency for meeting ecological success.

5 Budget Estimate

Budget estimates have been developed for monitoring and adaptive management measures separately. Table 1 summarizes a total estimate for the monitoring efforts in this plan, and Table 2 is the summary of the cost estimate for the recommended adaptive management measures. The cost estimate and associated contingency for monitoring is similar to Pacific Northwest ecosystem restoration projects of this scope and scale. Monitoring metrics, methods, and targets may be adjusted during PED phase as surveys, hydraulic modeling, and detailed designs are completed. The 25% contingency includes roughly $76,000 of contingency to address the residual risk associated with metrics, methods, or targets being adjusted based on final design as well as potential changes in site-specific conditions between the feasibility phase and construction that may cause monitoring plans to be adjusted. Contingency for adaptive management costs is in alignment with contingency for the relevant components from the construction cost estimates.

Table 1. Estimated cost of monitoring effort for the North Fork Skagit River Delta

Activity	**Budget**
Physical Monitoring	$62,000
Biological Monitoring	$132,000
Vehicles, equipment, travel	$28,000
Coordination and Reporting	$81,000
Estimate	**$303,000**
Monitoring Total (Contingency of 25% added)	**$379,000**

Table 2. Potential adaptive management measures and their estimated costs.

Adaptive management measure	**Scale or extent of effort**	**Cost w/o Contingency**	**Cost + 36% Contingency**
Additional excavation on riverbank	Focus on breach locations; excavate approx. 60,000 cubic yards (cy)	$270,000	$367,200
Additional excavation in channels	Remove approximately 2,200 cy representing 6 inches to 1 foot	$15,000	$20,400
Additional large tree planting	Plant tree species across 10% of the planted area at 10 feet on center	$49,000	$66,640
Additional shrub planting	Plant shrub species across 10% of the planted area at 3 feet on center	$161,000	$218,960
Add anchored wood to banks of river or channels	Approximately 1 log per 40 feet of modified channel	$744,000	$1,011,840
Initiate work on site	1 mobilization and 1 de-mobilization of heavy equipment (Assume half the original mob/demob due to smaller scale of work for the adaptive management features)	$268,000	$364,480
Adaptive Management Total		$1,507,000	$2,049,520

6 Literature Cited

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Hood, G.W. 2009. Habitat Monitoring Strategy for the Tidal Skagit Delta: Integrating Landscape and Site-scale Perspectives. Prepared for the Skagit River System Cooperative, LaConner, WA

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Nooksack River Delta

1 Project Monitoring Objectives: Nooksack River Delta

As a restoration project, it is expected that this site will be dynamic and evolve. The monitoring and evaluation will focus on determining whether the overall project objectives of the restoration are being met. Monitoring efforts will be performed by using monitoring metrics. All post-construction monitoring will be performed by qualified biologists and hydraulic engineers.

Evaluating the success of the restoration site will be based on the establishment of the targeted habitat within the restoration site and on the ecological functioning of those habitats. All post-construction monitoring will be cost shared between the Corps and the non-Federal sponsors for the first 10 years of monitoring. The non-Federal sponsors may choose to monitor beyond this 10-year period, although the cost would be 100% their responsibility. Data collection will be used to determine success of the project with the focus on the development of estuarine and freshwater tidal wetlands and vegetated riparian zone. Restored wetlands can take decades to reach their dynamic equilibrium conditions, therefore the initial monitoring period of approximately 10 years will be assessed as to whether the structural template has been established and if the site is on a trajectory toward ecological success (Haltiner et al. 1997). The Corps and the non-Federal sponsors will use the knowledge gained through this monitoring to adaptively manage the project sites.

The following site-specific objectives have been identified for restoration at the Nooksack River Delta:

1. Reconnect and restore freshwater input to lost floodplain habitats including channel meander zone, shoreline complexity, and shaded refuge habitat in the Nooksack River Delta.
2. Restore tidal inundation to reconnect lost tidally influenced area including estuarine and freshwater tidal wetlands and tidal channels in the Nooksack River Delta.
3. Re-establish intertidal and shallow subtidal topography of the Nooksack River Delta to restore tidal prism and salinity gradient to increase nearshore habitat capacity and productivity for fish, birds, and other estuarine species.
4. Improve aquatic habitat connectivity and between lower river systems and upstream habitat networks of the Nooksack River.
5. Restore a more natural riparian corridor along the Nooksack River Delta.

These objectives are expected to achieve three different habitat types across the restoration site: tidal freshwater wetlands at the downstream end and lower elevations, scrub-shrub wetlands anticipated along the reconnected floodplain, and a vegetated riparian buffer zone. The site is expected to support a dynamic habitat mosaic as it reaches an equilibrium of restored interactive processes.

Section 3 lists monitoring metrics, performance targets, and potential adaptive management associated with the effectiveness monitoring, which aims to measure how well the habitat is developing according to performance criteria.

2 Reference Site

The reference site selected for the Nooksack and Lummi River Delta project site is the reach of the North Fork Skagit River that begins immediately adjacent to the downstream end of the North Fork Skagit project site (Figure 1). This reach is not considered to necessarily be in "historical condition" because upstream activities such as dams and farming over the past century have likely altered conditions that existed prior to these manipulations (Hood 2009). However, the reach has natural processes of sediment erosion and deposition, sustained tidal channels, as well as intact tidal inundation to sustain wetlands and is therefore a sufficient reference target for restoration of natural processes and ecosystem functions. The reference reach curves northward before turning west again to enter Puget Sound. The reach is approximately 2 miles long, and the left bank is mostly vegetated with no evidence of direct human interference. The right bank has a short modified reach but is otherwise natural. The channel width varies from 350 to 550 feet wide, which is roughly the same as the project site. The reference site is in the scrub-shrub zone and contains substantial native vegetation that can serve as a seed source as tidal inundation is restored to the project site, which will also be within the tidal elevations of the scrub-shrub zone once restored. The reference site contains all of the expected types of riverbank complexity features for this type of site including but not limited to shrubs, trees, accumulations of woody debris, varying substrate sizes, and erosional and depositional reaches. This reference site applies to all of the monitoring metrics listed in Section 3.

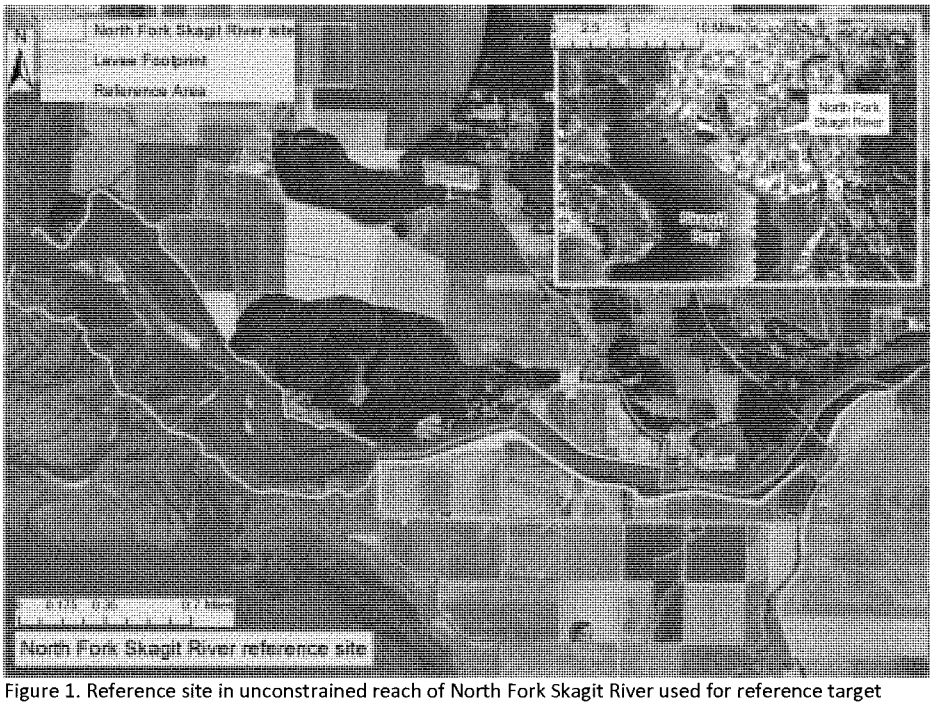

Figure 1. Reference site in unconstrained reach of North Fork Skagit River used for reference target conditions for the Nooksack River Delta project site.

3 Monitoring Metrics, Targets, and Adaptive Management Measures

All of the following metrics, methods, targets, and adaptive management measures may be adjusted during pre-construction, engineering, and design (PED) phase as surveys, hydraulic modeling, and detailed designs are completed.

3.1 Monitoring Metric 1: Increased tidal prism of water reaching a reconnected floodplain in Lummi River (Objectives 1-4)

Methods and Timing: Existing conditions were determined through LiDAR and established NOAA tide stations; however, this method does not provide data with the local accuracy required for post-construction monitoring and adaptive management. To determine whether the site is reaching the performance target stated below, a water surface gauge or pressure sensing data logger will be installed at the downstream end of the site near or at the Hillaire Road bridge. This sensor will be used to measure the tidal and riverine elevations and to quantify frequency, duration, and area of tidal inundation in the tidally influenced portion of the restored site on the Lummi River (Roegner et al. 2009). The sensor will be checked every 3-6 months. The data will be used to estimate intertidal prism parameters such as areas of highest and lowest tidal inundation and to calculate the volumetric difference between high tide and low tide. Morphological feature extents in the landscape profile (channels, hummocks) will be noted. The complete dataset will be analyzed once per year in years 1, 2, 6, and 10 after construction to verify project success of providing tidal influence to the site (Neckles et al. 2002). The greatest change will occur in the first two years. Subsequent measurements every 4 years will quantify additional change toward site conditions that may not be stabilized until 20 or more years post-construction. This duration of monitoring will allow sufficient time for higher high tides and significant floods to exert influence over the substrate materials. The predicted response, as shown in Table 4-1 of the Monitoring Framework, is that the period of inundation will increase as tidal hydrology is restored, then will decrease as the marsh elevation increases. By 10 years post-construction, data will show the trajectory of site development and decisions can be made regarding whether contingency measures are required. Site topography data would be collected via remote sensing and on-the-ground survey making opportunistic use of other LiDAR efforts in the Puget Sound area.

Performance Target: The performance target is to achieve an inundation depth of at least 6 inches over 40% of the ground surface in the area of the levee setbacks once per tidal cycle for a duration of 2 hours by 10 years after construction.

Adaptive Management: If the site has not reached its performance target by 10 years after construction, then additional removal of material where the levees stood and/or more excavation at the breaches may be necessary. All site data should be integrated for a thorough analysis of conditions before additional construction actions are taken.

3.2 Monitoring Metric 2: Wetland development (Objectives 2 and 3)

Methods and timing: Two levees and one roadway berm will be removed during construction. The acreage of the footprints of these levees is 24 acres and the berm is 12 acres. The footprint is considered to be all of the area excavated to remove the levees and berms, which would become bare soil on the site. The footprint of each levee and berm removal area will be monitored to ensure the restored area is developing wetland characteristics. This is the critical area of disturbed soils that must be monitored.

Planting the entire 1,807-acre site would not likely be cost-effective and passive colonization has been determined to be a successful strategy for estuarine marshes (Hood 2009). The footprint of the levee removal area will be monitored to ensure the restored area is developing wetland characteristics. Wetland reconnaissance site visits will be conducted to document the presence/absence of hydric soils, hydrophytic vegetation, and wetland hydrology using the methods in the *USACE Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE 2010). Monitoring site visits will occur in years 2, 3, 6, and 10.

Performance Target: The target is for at least 80% of the levee removal footprint to be functioning wetland. If early monitoring results show that the site is not on a favorable trajectory to achieve the target, implementation of adaptive management measures should be evaluated to determine whether the trade-off is worth the site disturbance as implementation would likely destroy some plantings.

Adaptive Management: If the target is not met, then additional removal of material where the levees stood may be needed, and/or more excavation at the breaches may be necessary, to be determined at year 10, but no more than 10% of initial construction quantities. The area would need to be analyzed for whether it can be manipulated to create hydrological conditions to support wetland soils and plants, and sampling could move outside of the removed levee footprint for further investigation. The area should also be analyzed for whether it is providing equivalent functional value of a different habitat type to the performance target before undertaking any construction measures to meet the previously stated performance target.

3.3 Monitoring Metric 3: Increased area of soil salinity gradient (Objectives 2 and 3)

Methods and Timing: Monitoring effort will sample soil salinity during low tide at various ground elevations along transects across the Lummi River portion of the site. Sampling timing will be focused on plant growing seasons and location will be focused on critical rooting depths.

Performance Target: The performance target for the Lummi River area that is at or below mean tide level is to have soil salinity levels within the range of at least 5-15 parts per thousand (ppt) to assist with saltmarsh development. This parameter will be monitored in years 2, 3, 6, and 10 after construction to verify project success of providing tidal influence to the site for the expansion of salt marsh habitat. This sampling will be combined with other metrics to follow the same transects. This duration of monitoring will allow sufficient time for higher high tides to exert influence over the substrate materials and excavated channels.

Adaptive Management: If the target of reaching the range of soil salinity levels is not achieved, then additional removal of material where the levees stood may be needed, and/or more excavation to create breaches in the bank at the downstream end of the site may be necessary to meet the tidal exchange and salinity levels for saltmarsh establishment.

3.4 Monitoring Metric 4: Density of native woody species (Objectives 1, 2, and 5)

Methods and timing: Measure plant stem density along established transects of all planted areas during the late summer when seasonal vegetative growth is at its fullest. Installed plant density is projected to be 32 shrubs per 1,000 square feet (planted 6 feet on center) and 5 trees per 1,000 square feet (planted

15 feet on center). Thus, the 80% performance target density would be 26 shrubs and 4 trees per 1,000 square feet. Post-construction monitoring is recommended to occur in year 3, since the contractor will be responsible for 100% survival of planted vegetation for the first year.

Performance Target: Native woody species (planted and volunteer) will achieve an average stem density of at least 80% of the installed plant density in all planted areas of the site by year 3. This target density will be represented by native Puget Sound lowlands species. Trees and shrubs typically found in the Puget Sound lowlands may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)
- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Adaptive Management: If the above target is not met, then additional plantings would be installed and/or changes in species planted from original planting plan if survival of certain species is low. Additional irrigation of plants may need to be provided if they appear to have been water stressed during the first three years.

The local sponsor will monitor for invasive species; this must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. Invasive species shall not exceed 10% of the total plant coverage on the site. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

3.5 Monitoring Metric 5: Aerial coverage of native woody vegetation (Objectives 1-5)

Methods and Timing: Measure percent aerial cover along established transects of all planted areas during late summer when seasonal vegetative growth is at its fullest. Aerial cover is the percentage of the ground surface covered by the aerial portions (leaves and stems) of a plant species when viewed from above. The surveyed area should include all ground disturbed by construction, and all planting areas at a minimum. Post-construction monitoring is recommended to occur in years 3, 6, and 15. Years 6 and 15 are included to provide a reasonable amount of time for shrubs to reach maturity and trees to reach the height that provides a strong chance of survival so the Corps can determine whether sufficient cover has been achieved or whether an adaptive management measure must be implemented. Any monitoring that occurs after year 10 will be 100% cost of the non-Federal sponsor.

Performance Target: It is expected that coverage will increase as planted and volunteer species grow. Planted and native volunteer trees and shrubs should be healthy and have a high percentage of aerial coverage. Trees and shrubs typically found in the Puget Sound lowlands that may colonize the site may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)

- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Performance targets include the following:

- Year 3: at least 30% aerial cover of native shrub and/or tree species
- Year 6: at least 60% aerial cover of native shrub and/or tree species
- Year 15: at least 80% aerial cover of native shrub and/or tree species

Adaptive Management: If the above targets are not met, then additional plantings would be implemented and/or changes in species planted from original planting plan if survival of certain species is low. Additional irrigation of plants may need to be provided if they appear to be water stressed during the first three years.

The local sponsor will monitor for invasive species; this must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. Invasive species shall not exceed 10% of the total plant coverage on the site. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

3.6 Monitoring Metric 6: Appropriate river flows restored to Lummi River through Diversion Structure (Objective 1)

Methods and Timing: Measure stage, water flow (discharge), and temperature at the outlet of the diversion structure using a data logger. These parameters will be monitored continuously for at least the first 10 years after construction to verify project success of providing improved flow quantity and duration to the Lummi River. The data logger will be active for at least three months of each year. This duration of monitoring will allow sufficient time for higher river flows to occur to determine appropriate functioning range of the diversion structure. The purpose for monitoring temperature is to ensure no deleterious effects to water quality in either fork of the river.

Performance Target: The performance target for the restoration is to have up to 200 cubic feet per second (cfs) from the Nooksack River flow into the Lummi River during the months of February through April to assist the outmigration of juvenile fish. During periods of low flow (late summer/early fall) or poor water quality in the Nooksack River, the diversion structure may require lower flows.

Adaptive Management: If the target of achieving 200 cfs in February through April is not met, or if impacts to water temperature are detected in either fork of the river, then modification of the diversion structure would be required.

4 Contingency Planning and Implementation

Contingency measures (adaptive management) will be implemented if the monitoring program indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-Federal sponsor would then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. Monitoring and adaptive

management activities in this plan will be refined in PED phase. Additional metrics, methods, performance targets, and adaptive management measures may be added if needs are identified.

The general timeline for meeting performance targets is 6-10 years after construction. This is estimated to be sufficient time to determine ecological success or at least a site's trajectory toward success through measurement of the physical and biological parameters outlined in this monitoring and adaptive management plan. Many metrics require sampling through at least year 6 post-construction. The Corps and non-Federal sponsor should analyze all data collected to this point and make an assessment as to whether ecological success has been achieved, or if the site is on a trajectory predicted to achieve success. An assessment can be made as to whether the monitoring should continue through year 10. If monitoring continues through year 10, it is at this point that the project partners should make an assessment as to whether any of the adaptive management measures should be implemented as a contingency for meeting ecological success.

5 Budget Estimate

Budget estimates have been developed for monitoring and adaptive management measures separately. Table 1 summarizes a total estimate for the monitoring efforts in this plan, and Table 2 is the summary of the cost estimate for the recommended adaptive management measures. The cost estimate and associated contingency for monitoring is similar to Pacific Northwest ecosystem restoration projects of this scope and scale. Monitoring metrics, methods, and targets may be adjusted during PED phase as surveys, hydraulic modeling, and detailed designs are completed. The 25% contingency includes roughly $101,000 of contingency to address the residual risk associated with metrics, methods, or targets being adjusted based on final design as well as potential changes in site-specific conditions between the feasibility phase and construction that may cause monitoring plans to be adjusted. Contingency for adaptive management costs is in alignment with contingency for the relevant components from the construction cost estimates.

Table 1. Estimated cost of monitoring effort for the Nooksack River Delta

Activity	**Budget**
Physical Monitoring	$123,000
Biological Monitoring	$154,000
Vehicles, equipment, travel	$47,000
Coordination and Reporting	$81,000
Estimate	**$405,000**
Monitoring Total (Contingency of 25% added)	**$506,000**

Table 2. Potential adaptive management measures and their estimated costs.

Adaptive management measure	Scale or extent of effort	Cost w/o Contingency	Cost + 40% Contingency
Additional excavation on riverbank where levees were removed	Excavate an additional 10,000 cy (10% of quantities removed during construction)	$53,000	$74,200
Additional large tree planting	Plant tree species across 10% of the planted area or along riverbank at 10 feet on center. 1665 total trees.	$28,000	$39,200
Additional shrub planting	Plant shrub species across 10% of the planted area at 3 feet on center. 18500 shrubs total.	$229,000	$320,600
Add anchored wood to banks of river or channels	Approximately 1 log per 40 feet of modified channel. 238 Logs total.	$394,000	$551,600
Initiate work on site	1 mobilization and 1 de-mobilization of heavy equipment (Assume half the original mob/demob due to smaller scale of work for the adaptive management features)	$85,000	$119,000
Adaptive Management Total		$789,000	$1,104,600

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Duckabush River Estuary

1 Project Monitoring Objectives: Duckabush River Estuary

As a restoration project, it is expected that this site will be dynamic and evolve. Thus, for some parameters, strict achievement of predetermined performance standards will not necessarily predict the success or reveal the failure of the restoration effort. The monitoring and evaluation will focus on determining whether the overall project objectives of the restoration are being met. Monitoring efforts will be performed by using monitoring metrics. All post-construction monitoring will be performed by qualified biologists and hydraulic engineers.

Evaluating the success of the restoration site will be based on the establishment of the targeted habitat within the restoration site and on the ecological functioning of those habitats. All post-construction monitoring will be cost shared between the Corps and the non-Federal sponsors for the first 10 years of monitoring. The non-Federal sponsors may choose to monitor beyond this 10-year period, although the cost would be 100% their responsibility. Data collection will be used to determine success of the project with the focus on the development of estuarine and freshwater tidal wetlands and vegetated riparian zone. Restored wetlands can take decades to reach their dynamic equilibrium conditions, therefore the initial monitoring period of approximately 10 years will be assessed as to whether the structural template has been established and if the site is on a trajectory toward ecological success (Haltiner et al. 1997). The Corps and the non-Federal sponsors will use the knowledge gained through this monitoring to adaptively manage the project sites.

The following site-specific objectives have been identified for restoration at the Duckabush River Estuary:

1. Reconnect and restore lost tidally influenced areas including estuarine and freshwater tidal wetlands in the Duckabush River Estuary.
2. Re-establish distributary channels in the Duckabush River Estuary to promote greater diversity of delta wetland habitats.
3. Restore mudflats and salt marsh in the Duckabush River Estuary.

These objectives are expected to achieve four different habitat types across the restoration site: mudflats and emergent saltmarsh wetlands at the downstream end and lower elevations, a scrub-shrub wetland ecotone across most of the site given the existing and anticipated intertidal elevations, and substantial lengths of saltwater tidal channels. The excavated tidal channels will intersect all of these habitat zones and restore the process of exchange of aquatic organisms. The site is expected to support a dynamic habitat mosaic as it reaches an equilibrium of restored interactive processes.

Section 3 lists monitoring metrics, performance targets, and potential adaptive management associated with the effectiveness monitoring, which aims to measure how well the habitat is developing according to performance criteria.

2 Reference Site

The reference site selected for the Duckabush Estuary project site is Dewatto River Estuary (Figure 1). This small river delta is less than 15 miles away across Hood Canal from Duckabush Estuary and is substantially similar to Duckabush River in its hydrologic regime, geomorphology, and suite of representative species including federally protected salmon species, marine bird concentrations, shellfish presence, and eelgrass meadows. This site is the nearest estuary relatively undisturbed estuary with similar characteristics to Duckabush and is among the least degraded estuaries in Puget Sound (Cereghino et al. 2012). Dewatto estuary has no substantial fill or constrictions and has natural processes of sediment erosion and deposition, sustained tidal channels, as well as intact tidal inundation to sustain wetlands and is therefore a sufficient reference target for restoration of natural processes and ecosystem functions. The delta is formed by the mouth of Dewatto River, which drains from the Kitsap Peninsula into the east shore of Hood Canal. The width of the estuary ranges from 650 to 1,200 feet wide. The site contains fringes of saltmarsh vegetation. This reference site applies to all of the monitoring metrics listed in Section 3.

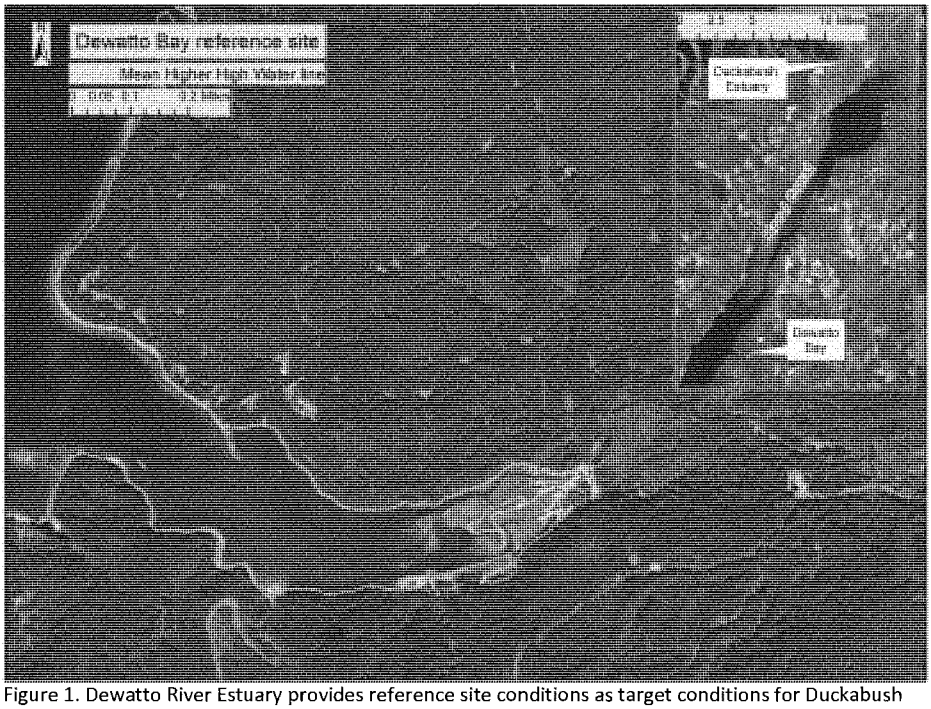

Figure 1. Dewatto River Estuary provides reference site conditions as target conditions for Duckabush River Estuary project site.

3 Monitoring Metrics, Targets, and Adaptive Management Measures

All of the following metrics, methods, targets, and adaptive management measures may be adjusted during pre-construction, engineering, and design (PED) phase as surveys, hydraulic modeling, and detailed designs are completed.

3.1 Monitoring Metric 1: Increased tidal prism of water reaching a reconnected floodplain (Objectives 1 and 3)

Methods and Timing: Existing conditions were determined through LiDAR and established NOAA tide stations; however, this method does not provide data with the local accuracy required for post-construction monitoring and adaptive management. To determine whether the site is reaching the performance target stated below, a water surface gauge or pressure sensing data logger will be installed near or at the existing southern Highway 101 bridge. An additional sensor may be required at the reference site. These sensors will be used to measure the tidal elevations and to quantify frequency, duration, and area of tidal inundation (Roegner et al. 2009). The sensors will be checked every 3-6 months. The data will be used to estimate intertidal prism parameters such as areas of highest and lowest tidal inundation and to calculate the volumetric difference between high tide and low tide. Morphological feature extents in the landscape profile (channels, hummocks) will be noted. The complete dataset will be analyzed once per year in years 1, 2, 6, and 10 after construction to verify project success of providing tidal influence to the site (Neckles et al. 2002). The greatest change will occur in the first two years. Subsequent measurements every 4 years will quantify additional change toward site conditions that may not be stabilized until 20 or more years post-construction. This duration of monitoring will allow sufficient time for higher high tides and significant floods to exert influence over the substrate materials and excavated channels. The predicted response, as shown in Table 4-1 of the Monitoring Framework, is that the period of inundation will increase as tidal hydrology is restored. By 10 years post-construction, data will show the trajectory of site development and decisions can be made regarding whether contingency measures are required. Site topography data will be collected via remote sensing and on-the-ground survey making opportunistic use of other LiDAR efforts in the Puget Sound area.

If a flood level greater than a 2% Annual Exceedance Probability occurs within the first 15 years after construction, then the site should undergo an additional monitoring assessment. Any monitoring after 10 years post-construction is at 100% cost of the non-federal sponsor.

Performance Target: The performance target is to achieve an inundation depth of at least 3 feet in the thalweg of the excavated large distributary channels for 40-60% of the tidal cycle for at least 70% of the lineal distance of the channel. The target in the small distributary channels is to achieve an inundation depth of at least 3 feet in the thalweg of the excavated small distributary channels at least once per tidal cycle for a duration of 3 hours for at least 70% of the lineal distance of the channel.

Adaptive Management: If the site has not reached its performance target by 10 years after construction, then additional removal of material where the highway crossed the delta may be needed, and/or more excavation along the channels may be necessary. All site data should be integrated for a thorough analysis of conditions before additional construction actions are taken.

3.2 Monitoring Metric 2: Wetland development (Objectives 1, 2, and 3)

Methods and timing: One section of bank armoring will be removed during construction. The acreage of the footprint of this bank armoring is 0.4 acres. The footprint is considered to be all of the area excavated to remove the bank armoring, which would become bare soil on the site. The footprint of the armoring removal area will be monitored to ensure the restored area is developing wetland characteristics. This is the critical area of disturbed soils that must be monitored. Planting the entire 38-acre site would not likely be cost-effective and passive colonization has been determined to be a successful strategy for estuarine marshes (Hood 2009). The footprint of the levee removal area will be monitored to ensure the restored area is developing wetland characteristics. Wetland reconnaissance site visits will be conducted to document the presence/absence of hydric soils, hydrophytic vegetation, and wetland hydrology using the methods in the *USACE Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE 2010). Monitoring site visits will occur in years 2, 3, 6, and 10.

Performance Target: The target is for at least 80% of the levee removal footprint to be functioning wetland. If early monitoring results show that the site is not on a favorable trajectory to achieve the target, implementation of adaptive management measures should be evaluated to determine whether the trade-off is worth the site disturbance as implementation would likely destroy some plantings.

Adaptive Management: If the target is not met, then additional removal of material where the levees stood may be needed, and/or more excavation at the breaches may be necessary, but no more than 10% of initial construction quantities. The area would need to be analyzed for whether it can be manipulated to create hydrological conditions to support wetland soils and hydrophytic plants. The area should also be analyzed for whether it is providing equivalent functional value of a different habitat type (e.g. upland riparian habitat) to the performance target before undertaking any construction measures to meet the previously stated performance target.

3.3 Monitoring Metric 3: Increased area of soil salinity gradient (Objectives 1 and 3)

Methods and Timing: Sample soil salinity during low tide at various ground elevations along transects across the site. Sampling timing will be focused on plant growing seasons and location will be focused on critical rooting depths.

Performance Target: The performance target for the restoration area that is at or below mean tide level is to have soil salinity levels in the within the range of at least 5-15 parts per thousand (ppt) to assist with saltmarsh development. This parameter will be monitored in years 2, 3, 6, and 10 after construction to verify project success of providing tidal influence to the site for the expansion of salt marsh habitat. This sampling will be combined with other metrics to follow the same transects. This duration of monitoring will allow sufficient time for higher high tides to exert influence over the substrate materials and excavated channels.

Adaptive Management: If the target of reaching the range of soil salinity levels is not achieved, then additional removal of material where the bank armoring stood and the highway removal area may be needed to meet the tidal exchange and salinity levels for saltmarsh establishment.

3.4 Monitoring Metric 4: Density of native woody species (Objectives 1, 2, and 5)

Methods and timing: Measure plant stem density along established transects of all planted areas during the late summer when seasonal vegetative growth is at its fullest. Post-construction monitoring is recommended to occur in year 3, since the contractor will be responsible for 100% survival of planted vegetation for the first year.

Performance Target: Native woody species (planted and volunteer) will achieve an average stem density of at least 80% of the installed plant density in all planted areas of the site by year 3. Installed plant density is projected to be 32 shrubs per 1,000 square feet (planted 6 feet on center) and 5 trees per 1,000 square feet (planted 15 feet on center). Thus, the 80% performance target density would be 26 shrubs and 4 trees per 1,000 square feet. This target density will be represented by native Puget Sound lowlands species. Trees and shrubs typically found in the Puget Sound lowlands may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)
- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Adaptive Management: If the above target is not met, then additional plantings would be installed. If survival of certain species from the original planting plan is low, changes in species planted may be necessary. Additional irrigation of plants may need to be provided if they appear to have been water stressed during the first three years.

The local sponsor will monitor for invasive species; this must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. Invasive species shall not exceed 10% of the total plant coverage on the site. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

3.5 Monitoring Metric 5: Aerial coverage of native woody vegetation (Objectives 1 and 3)

Methods and Timing: Measure percent aerial cover along established transects of all planted areas during late summer when seasonal vegetative growth is at its fullest. Aerial cover is the percentage of the ground surface covered by the aerial portions (leaves and stems) of a plant species when viewed from above. The surveyed area should include all ground disturbed by construction, and all planting areas at a minimum. The timing assumes that very little vegetation would have established and exhibited any notable growth in the first 2 years. Post-construction monitoring is recommended to occur in years 3 and 6 (Neckles et al. 2002). Year 6 is included to provide a reasonable amount of time for shrubs to reach maturity so the Corps can determine whether sufficient cover has been achieved or whether an adaptive management measure must be implemented.

Performance Target: It is expected that coverage will increase as planted and volunteer species grow. Planted and desirable volunteer trees and shrubs should be healthy and have a high percentage of aerial

coverage. Trees and shrubs typically found in the Puget Sound lowlands may include, but are not limited to, the following species (Brennan 2007):

- Shrubs: Salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*)
- Trees: Western red cedar (*Thuja plicata*), Western hemlock (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*)

Performance targets include the following:

- Year 3: at least 30% aerial cover of native shrub species
- Year 6: at least 60% aerial cover of native shrub species

Adaptive Management: If the above targets are not met, then a planting plan should be designed and implemented. This should include removal of any plant species that pose a risk to establishment of native and/or otherwise beneficial recruited species.

The local sponsor will monitor for invasive species; this must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

4 Contingency Planning and Implementation

Contingency measures (adaptive management) will be implemented if the monitoring program indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-Federal sponsor would then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. Monitoring and adaptive management activities in this plan will be refined in PED phase. Additional metrics, methods, performance targets, and adaptive management measures may be added if needs are identified.

The general timeline for meeting performance targets is 6-10 years after construction. This is estimated to be sufficient time to determine ecological success or at least a site's trajectory toward success through measurement of the physical and biological parameters outlined in this monitoring and adaptive management plan. Many metrics require sampling through at least year 6 post-construction. The Corps and non-Federal sponsor should analyze all data collected to this point and make an assessment as to whether ecological success has been achieved, or if the site is on a trajectory predicted to achieve success. An assessment can be made as to whether the monitoring should continue through year 10. If monitoring continues through year 10, it is at this point that the project partners should make an assessment as to whether any of the adaptive management measures should be implemented as a contingency for meeting ecological success.

5 Cost

Budget estimates have been developed for monitoring and adaptive management measures separately. Table 1 summarizes a total estimate for the monitoring efforts in this plan, and Table 2 is the summary of the cost estimate for the recommended adaptive management measures. The cost estimate and associated contingency for monitoring is similar to Pacific Northwest ecosystem restoration projects of this scope and scale. Monitoring metrics, methods, and targets may be adjusted during PED phase as surveys, hydraulic modeling, and detailed designs are completed. The 25% contingency includes roughly $41,000 of contingency to address the residual risk associated with metrics, methods, or targets being adjusted based on final design as well as potential changes in site-specific conditions between the feasibility phase and construction that may cause monitoring plans to be adjusted. Contingency for adaptive management costs is in alignment with contingency for the relevant components from the construction cost estimates.

Table 1. Estimated cost of monitoring effort for the Duckabush River Estuary

Activity	**Budget**
Physical Monitoring	$53,000
Biological Monitoring	$42,000
Vehicles, equipment, travel	$15,000
Coordination and Reporting	$54,000
Estimate	**$164,000**
Monitoring Total (Contingency of 25% added)	**$205,000**

Table 2. Potential adaptive management measures and their estimated costs.

Adaptive management measure	Scale or extent of effort	Cost w/o Contingency	Cost + 46% Contingency
Additional excavation where highway crossed delta	Excavate approx. 1,600 cubic yards (cy), based on 30 feet wide 1,400 feet long	$450,000	$657,000
Additional excavation where bank armoring stood	Remove approx. 150 cy along river banks to lower bank elevation by 2 feet	$42,000	$61,320
Additional excavation in channels	Remove approximately 3,000-5,000 cy representing 6 inches to 1 foot	$628,000	$916,880
Additional shrub planting	Plant shrub species across 10% of the highway removal and armor removal areas at 3 feet on center. 1280 shrubs total.	$15,000	$21,900
Add anchored wood to banks of river or channels	Approximately 1 log per 40 feet of modified channel. 105 logs total.	$203,000	$296,380
Initiate work on site	1 mobilization and 1 de-mobilization of heavy equipment (Assume half the original mob/demob due to smaller scale of work for the adaptive management features)	$134,000	$195,640
Adaptive Management Total		$1,472,000	$2,149,120

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Puget Sound Nearshore Ecosystem Restoration Project Monitoring Framework

February 2013

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PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

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List of Acronyms

BACI	Before-After-Control-Impact
EFG&S	Ecosystem Functions, Goods, and Services
GI	General Investigation
LWD	Large Woody Debris
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
VEC	Valued Ecosystem Component
WDFW	Washington Department of Fish and Wildlife
WRDA	Water Resources Development Act

1. Introduction

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a large-scale, comprehensive initiative to protect and restore the natural processes, structures, and functions of Puget Sound's nearshore ecosystems. The initiative is being conducted under the U.S. Army Corps of Engineers (Corps) general investigation (GI) authority with the Washington State Department of Fish and Wildlife (WDFW) serving as the non-Federal sponsor. This GI is intended to support broader restoration efforts in the Puget Sound region, including those being coordinated by the Puget Sound Partnership. The culmination of this GI is the delivery of a Final Feasibility Report with a near-term plan of action, which includes recommendation for authorization of strategically selected restoration sites for implementation by the Corps.[1]

Successful ecosystem restoration requires two basic tools: the ability to alter ecosystems to recreate a desired condition, and the ability to determine whether those manipulations have produced, or are producing, the desired condition (Keddy 2000). This second tool is achieved through systematic monitoring of restoration outcomes. Accordingly, Corps regulations require as an element of the Feasibility Report a plan for "monitoring the success of the ecosystem restoration" (USACE 2009). The monitoring plan must focus on key indicators of project performance to address the question of whether restoration sites and associated management measures are achieving stated objectives.

In its Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA), the Corps 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 2009). In this context, the Corps uses the term "adaptive management" to denote "contingency planning" – in other words, determining the need for, and implementing, mid-course corrections to restoration actions. Thus, the Corps recognizes that even the most strategically planned restoration actions can yield unexpected results. Comprehensive monitoring of a site documents and diagnoses these results especially in the early, formative stages, providing information useful for taking corrective action. In this way, it reduces the risk of failure and enables effective, responsive management of restoration actions.

The restoration sites selected by PSNERP employ a suite of management measures that attempt to address a complex set of objectives. These management measures are linked to their predicted ecological outcomes through a series of assumptions. While these assumptions are based on the best current scientific understanding, they involve scientific uncertainties inherent in ecosystem restoration. Monitoring and adaptive management

[1] As "restoration" is used here, it encompasses restoration activities as well as preservation and protection of undegraded sites. Preservation that is recommended as the result of a Corps feasibility study is the responsibility solely of the non-Federal sponsor.

provides a mechanism for testing assumptions and further reducing these uncertainties. As the scientific record develops, relationships, conceptual models, management measures, and ultimately restoration designs can be refined for use in future actions or to improve existing actions.

Comprehensive monitoring of any restoration program generally falls into three broad categories:

> **Implementation monitoring**, also known as compliance monitoring, evaluates whether or not planned restoration tasks have been carried out as intended. In other words, implementation monitoring is designed to answer the questions, "Did we do what we said we would do? Did we follow all applicable standards and guidelines when we did it?"
>
> **Effectiveness monitoring** evaluates whether or not restoration actions are achieving their stated objectives. Effectiveness monitoring is designed to answer the question, "Did the completed actions achieve the intended outcomes? To what degree did we meet our site-specific objectives?"
>
> **Validation monitoring** tests the assumptions linking objectives and program goals. It is designed to answer the question, "Are these objectives the right ones to achieve program goals, or are our underlying assumptions wrong?"

All three types of monitoring are critical to the success of a restoration program. The monitoring framework presented in this document focuses primarily on effectiveness monitoring, as it is the fundamental monitoring responsibility of the Corps and non-Federal sponsor. Validation monitoring is necessary for programmatic adaptation and learning, but is presented as secondary in this framework to reflect its prioritization level. The completion of implementation monitoring is assumed to be part of project construction best practices. Thus, guidance for implementation monitoring is outside of the scope of this document.

This document is intended to support comprehensive decision-making for the construction phase of the program, including engineering and design of restoration sites. It will be used to develop individual site-specific monitoring plans for the proposed restoration sites, providing a framework to assess the effectiveness of actions taken to restore nearshore ecosystem processes by measuring the response of specific indicators. Successful implementation of these plans will also enhance understanding of physical and biological nearshore processes and the ecosystem goods and services they support. This understanding will benefit the broader restoration community of Puget Sound.

2. Background

2.1 Process-based Restoration

PSNERP's approach to the GI study is unique in that it focuses on understanding, evaluating, and restoring degraded ecosystem processes (Table 2-1). Where other restoration initiatives focus on addressing symptoms of ecosystem degradation such as single-species population decline or habitat loss, PSNERP's approach addresses the physiographic problems that underlie ecosystem degradation. The scientific and technical basis for this approach is documented in PSNERP guidance documents and reflects the emerging scientific discussion about the need to integrate understanding of ecosystem process into restoration planning. Goetz et al. (2004) stresses the importance of the physiographic processes that are responsible for building and sustaining landscape structures that support functions of an ecosystem. These structures and functions in turn provide valued ecosystem goods and services.

While full recovery of ecosystem function can be attempted through recreation of ecosystem structure, the long-term performance and effectiveness of such an approach is highly uncertain without restoration of the fundamental processes that maintain that structure (Simenstad et al. 2006). Indeed, there is little evidence for successful, long-term restoration of habitat structure. Restoration of degraded physiographic processes enables an ecosystem to be naturally productive, self-sustaining, and resilient, maximizing the likelihood that it will continue to provide functions, goods, and services into the future (Goetz et al. 2004, Greiner 2010, Cereghino et al. 2012).

2.2 Program Context: Prior Work by PSNERP

PSNERP was initiated in 2001 to evaluate the degradation of nearshore ecosystems in Puget Sound and to guide the restoration and protection of these ecosystems. To achieve this purpose, PSNERP initially gathered Sound-wide data to perform an analysis of historical change. This analysis quantified changes to the structure of Puget Sound's nearshore ecosystems over the past as a proxy for understanding historical nearshore processes (Simenstad et al. 2011). Results of the analysis indicated dramatic changes in Puget Sound nearshore ecosystems, including loss of wetlands, coastal embayments, and other landforms, and widespread distribution of stressors that impact ecosystem processes. The impact of these changes on nearshore ecosystem functions, goods, and services was also evaluated (Fresh et al. 2011, Simenstad et al. 2011, Cereghino et al. 2012).

To understand better the observed changes and loss, PSNERP conducted a Strategic Needs Assessment to characterize the impact of anthropogenic shoreline alterations on nearshore ecosystem processes (Schlenger et al. 2011). The assessment identified the major stressors contributing to the observed degradation, and quantified this degradation for 11 critical landscape-forming processes (Table 2-1). The assessment also assessed the impact of major stressors on valued ecosystem functions, goods, and services. The result was a clear problem statement identifying the major changes in Puget Sound nearshore ecosystems that should be the focus of restoration and protection actions (Fresh et al. 2011).

Table 2-1: PSNERP Nearshore Ecosystem Processes. The broad physiographic processes identified by PSNERP as critical for creation, maintenance, and function of Puget Sound's nearshore ecosystems. From Simenstad et al. 2011.

Nearshore Ecosystem Process	Process Description
Sediment input	Delivery of sediment from bluff, stream, and marine sources to Puget Sound shorelines; depending on landscape setting, inputs can vary in scale from acute, low-frequency episodes (hillslope mass wasting from bluffs) to chronic, high-frequency events (some streams and rivers). Sediment input interacts with sediment transport to control the structure of beaches.
Sediment transport	Bedload and suspended transport of sediments and other matter by water and wind along (longshore) and across (cross-shore) the shoreline. The continuity of sediment transport strongly influences the longshore structure of beaches.
Erosion and accretion of sediments	Deposition (dune formation, delta building) of non-suspended (e.g., bedload) sediments and mineral particulate material by water, wind, and other forces. Settling (accretion) of suspended sediments and organic matter on marsh and other intertidal wetland surfaces. These processes are responsible for creation and maintenance of barrier beaches (e.g., spits) and tidal wetlands.
Tidal hydrology	Localized tidal effects on water elevation and currents, differing significantly from regional tidal regime mostly in tidal freshwater and estuarine ecosystems.
Distributary channel migration	Change of distributary channel form and location caused by combined freshwater and tidal flow. Distributary channel migration affects the distribution of alluvial material across a river delta.
Tidal channel formation and maintenance	Geomorphic processes, primarily tidally driven, that form and maintain tidal channel geometry. Natural levee formation.
Freshwater input	Freshwater inflow from surface (stream flow) or groundwater (seepage) in terms of seasonal and event hydrography. Freshwater input affects the pattern of salinity and sediment and soil moisture content near shore.
Detritus import and export	Import and deposition of particulate (dead) organic matter. Soil formation. Recruitment, disturbance, and export of large wood.
Exchange of aquatic organisms	Organism transport and movement driven predominantly by water (tidal, fluvial) movement.
Physical disturbance	Change of shoreline shape or character caused by exposure to local wind and wave energy input. Localized and chronic disturbance of biotic assemblages caused by large wood movement, scour, and overwash.
Solar incidence	Exposure, absorption, and reflectance of solar radiation (e.g., radiant light and heat) and resulting effects. Solar incidence controls photosynthesis rates and temperature patterns in nearshore ecosystems.

From this problem statement, PSNERP developed four program-scale objectives for achieving process-based nearshore restoration in Puget Sound:

1. Restore the size and quality of large river delta estuaries and nearshore processes the deltas support.
2. Restore the number and quality of coastal embayments.
3. Restore the size and quality of beaches and bluffs.
4. Increase understanding of natural process restoration in order to improve effectiveness of program actions.

These objectives provide a planning framework from which more specific ecosystem objectives and restoration actions can be developed.

2.3 Restoration Approach

In order to address program-scale objectives, PSNERP developed four restoration and protection strategies that focus on restoration of river deltas, beaches, barrier embayments, and coastal inlets (Cereghino et al. 2012). This classification scheme is consistent with Shipman's (2008) division of the Puget Sound shoreline by geomorphic system, and reflects the four distinct ways that nearshore processes structure the shoreline in each system. Accordingly, each system supports a distinct set of ecosystem functions, goods, and services. All four systems are required for restoration of historical ecosystem services provided by nearshore ecosystems (Cereghino et al. 2012).

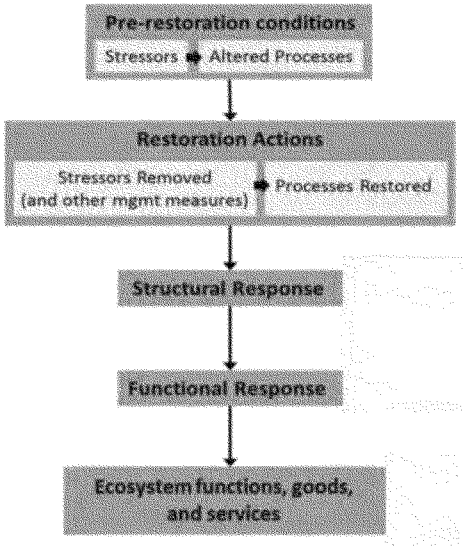

Figure 2-1: Basic conceptual model of process-based restoration.

Each strategy aims to restore critical landscape-forming processes by using management measures that remove the stressors currently impeding those processes (Clancy et al. 2009). Once restored, the processes are hypothesized to initiate structural and functional responses, ultimately leading to a productive, self-sustaining, and resilient system capable of producing the valued ecosystem goods and services historically associated with that strategy (Figure 2-1). The relationship between management measures, target processes, and ecosystem structures and functions for each strategy is based on a conceptual model derived from current scientific understanding of the system (Simenstad et al. 2006; Clancy et al. 2009). Specific conceptual models for each of the four landform strategies are

described later in this document.

Management measures may be applied alone or in combination to remove stressors and restore target processes. Restoration sites consist of one or more management measures applied at one or more discrete locations, constructed concurrently or in succession. Eighteen restoration sites have been selected as part of the near-term plan for the GI, and are recommended for authorization and implementation by the Corps. These sites were selected from lists of restoration opportunities identified by various governmental and non-governmental organizations throughout Puget Sound (ESA 2011). As a group, they cover all four strategies, addressing the broad suite of process-based PSNERP objectives and contributing to the recovery of lost functions, goods, and services of nearshore ecosystems in Puget Sound. The sites, and the restoration strategies to which they belong, are listed in Table 2-2. Although the sites selected by PSNERP were used to develop this framework, it is intended to be applicable to any action designed to restore nearshore processes in river deltas, beaches, barrier embayments, or coastal inlets in Puget Sound.

Table 2-2: PSNERP Restoration Strategies and Associated Sites.

Strategy	Description	Target Processes	Primary Management Measures	Selected Sites
River Deltas	Restore freshwater input and tidal processes where major river floodplains meet marine waters	Tidal hydrology Freshwater input	Berm or dike removal	1. Nooksack River Delta 2. Everett Marshland 3. Telegraph Slough 4. Deepwater Slough 5. Milltown Island 6. Spencer Island 7. North Fork Skagit River Delta 8. Duckabush River Estuary
Beaches	Restore sediment input and transport processes to littoral drift cells where bluff erosion sustains beach structure	Sediment supply	Armor removal Groin removal	1. Beaconsfield Feeder Bluff 2. WDNR Budd Inlet Beach

Strategy	Description	Target Processes	Primary Management Measures	Selected Sites
Barrier Embayments	Restore sediment input and transport processes to littoral drift cells where bluff erosion sustains barrier beaches that form barrier embayments, and restore the tidal flow processes within these partially closed systems	Sediment supply Tidal hydrology	Berm or dike removal Fill removal Armor or groin removal	1. Point Whitney Lagoon 2. Livingston Bay 3. Dugualla Bay 4. Big Beef Creek Estuary
Coastal Inlets	Restore tidal flow processes in coastal inlets, and restore freshwater input and detritus transport processes within these open embayment systems	Freshwater input Tidal hydrology	Berm or dike removal Fill removal	1. Harper Estuary 2. Tahuya River Estuary 3. Snow Creek and Salmon Creek Estuary 4. Deer Harbor Estuary

3. Overview of Effectiveness Monitoring Framework

Effectiveness monitoring is the primary focus of this document, as it is the fundamental monitoring responsibility of the Corps and non-Federal sponsor. By evaluating performance criteria for each restoration action, effectiveness monitoring tests whether actions are achieving their stated ecological objectives. Measuring and tracking these criteria provides feedback to determine if any adjustments to the restoration action are necessary to improve its probability or degree of ecological success. If properly planned and maintained, this feedback leads to increased knowledge, reducing uncertainty in the outcomes of restoration, and allowing sequential improvement of management actions in meeting the objectives from site to project scales. This feedback is the basis of an adaptive management framework.

The extent to which different treatments are applied to address the same management objective, including no-action control treatments, determines whether the adaptive management program is considered "passive" or "active" (Murray and Marmorek, 2003). Currently, project managers perceive constraints within the Corps program, which likely preclude or limit actions that might be considered experimental in nature. Despite the recognized learning benefits associated with active adaptive management, these program constraints and associated funding limitations lead us to advance a narrower framework. This monitoring framework supports passive adaptive management at the site-specific scale, rather than more ambitious active programmatic adaptive management. If the authorizing environment for the program changes over the decades-long timeframe anticipated for implementation, this conservative approach may be reassessed and a more robust adaptive management approach developed.

3.1 Goals

The goals of effectiveness monitoring of PSNERP restoration actions are to:

1. Assess the effectiveness of restoration actions in achieving defined objectives;
2. Determine where corrective action is needed to improve the effectiveness of restoration actions, and inform decisions about how to take such corrective action; and
3. Reduce risks and uncertainties associated with future restoration actions by increasing understanding of the relationships between restoration actions and restored ecosystem processes, structures, and functions for Puget Sound nearshore ecosystems.

3.2 Approach

The four PSNERP restoration strategies identify management measures used to restore processes, which in turn generate a series of structural and functional responses specific to the ecosystem. These responses constitute a set of predicted ecological and other ecosystem goods and services outcomes that indicate the performance of the restoration site. Performance of the restoration site is documented through an evaluation of

monitoring results as measured against these predicted outcomes. Thus, these outcomes effectively serve as strategy-specific objectives. In order to achieve the monitoring goals stated above, effectiveness monitoring of PSNERP restoration sites must answer the question, "Do management measures as implemented restore processes necessary to achieve objectives of improved ecosystem functions, goods and services?"

Processes are inherently difficult to measure and quantify directly, and need to be related to expected structural and functional responses in order to fully demonstrate restoration performance. As a result, structural and functional responses are typically monitored directly as indicators of restored processes. The causal relationships among restored processes and structural and functional responses are defined by strategy-specific conceptual models. This approach is consistent with the analytical process used to define and plan restoration needs: using the same conceptual models, structural changes documented in the historical change analysis were translated into implications of process degradation (Simenstad et al. 2011).

3.3 Indicators and Metrics

Ecosystem interactions addressed in the conceptual models occur primarily between process and structure, with both separately and in combination influencing ecosystem functions (Simenstad et al. 2006; Clancy et al. 2009). For each strategy, there are also two levels of ecosystem processes: target processes, without which ecosystem restoration would be considered incomplete; and secondary processes, which rely on restoration of the target processes to operate most fully. These overlapping hierarchies are captured in monitoring by three levels of indicators of increasing complexity and interrelatedness:

Primary indicators are structural responses that are directly related (i.e., through a single causal relationship in the conceptual model) to the target processes for that strategy. For example, tidal hydrology is a target process for the river deltas strategy. Enhanced tidal prism is a direct result of restored tidal hydrology, and is monitored as a primary indicator for restoration sites in the river delta strategy.

Secondary indicators are structural responses that are supported by any combination of restored processes for that strategy, including target and secondary processes. Compared to primary indicators, they are less directly related to restoration of the target processes for that strategy. For example, colonization by native vegetation is a structural response in the river delta strategy that relies on two restored processes: erosion and accretion of sediments, and exchange of aquatic organisms. These two processes operate most fully where tidal hydrology and freshwater input – the two target processes for the river delta strategy – are fully restored (Cereghino et al. 2012).

Tertiary indicators are structural or functional responses that require the restoration of all nearshore processes for that strategy, including both target and secondary processes, and often one or more structural responses as well. Compared to primary and secondary indicators, they are the most complex and least directly related to restoration of the target processes for that strategy. For example, increased shoreline length and complexity is a structural response in the river delta

strategy that depends on at least partial restoration of all processes in the river delta strategy, as well as several structural responses, including marsh plain redevelopment and channel network redevelopment.

All three levels of indicators must be monitored to evaluate whether they follow a predicted response. This response is developed from the best scientific understanding of the system's evolution following implementation of the restoration site. Metrics for each indicator are selected to provide enough information to track an indicator through its predicted response, as well as to explain why an indicator is (or is not) developing as predicted. For example, in the river delta strategy, site-scale topography measurements will track marsh plain redevelopment over time. Should the marsh plain fail to redevelop, measurements of local sediment accretion and erosion may help provide an explanation.

In general, this monitoring framework anticipates the use of reference sites. A reference site provides a basis of comparison to the restoration site and to pre-restoration conditions, helps inform acceptable values for monitoring metrics (Goetz et al. 2004), and can serve as a covariate that takes into account natural variability (Roni et al. 2005). Use of reference sites is discussed further in Section 5.2.

Each indicator is presented in this document as an element in a monitoring table, together with its predicted response and the metrics required for assessment. Also listed are the primary processes that support it – in other words, the indicator can develop according to its predicted response only if those processes have been restored. Each indicator is also presented as an element in the conceptual model diagram (for example, Figure 4-2), either as a structural response or a primary functional response. This diagram provides a simplified graphical representation of the complex linkages between ecosystem processes, structures, and functions. One monitoring table and one conceptual model diagram are presented for each of the four PSNERP restoration strategies.

3.4 Uncertainties, Contingency Planning, and Programmatic Improvement

Several types of uncertainties exist in the practice of ecosystem restoration. These uncertainties are derived from:

The response of the system to restoration. These arise from assumptions made in the conceptual model and can introduce risk of failure or delay meeting objectives.

Cumulative effects. Multiple restoration actions, particularly within a shoreline "process unit", can interact in unpredictable ways with synergistic or countervailing results.[2]

[2] A "process unit" is the basic spatial unit of the PSNERP change analysis (Simenstad et al. 2010), strategic needs assessment (Schlenger et al. 2011), and strategies analysis for nearshore protection and restoration (Cereghino et al. 2012), It is defined as a segment of Puget Sound shoreline comprising a drift cell, within which beach sedimentary processes are confined by drift cell indicators of sediment transport, convergence, and divergence; and the adjacent upland watershed area.

External factors and constraints. Factors outside the control of the restoration action can affect performance. These may include uncertain future change such as accelerated sea level rise, or practical constraints such as human modifications to watersheds or protection of private property.

In the PSNERP monitoring framework, uncertainties can be addressed at three scales: (1) the individual restoration site scale; (2) the scale over which individual projects may interact across common nearshore ecosystem processes, (e.g., the shoreline process unit scale); and, (3) and the collection of PSNERP restoration sites, or program scale. Effectiveness monitoring reduces risk associated with uncertainties at the site scale through contingency planning. At the program scale, information from effectiveness monitoring is used for programmatic improvement.

At the site scale, effectiveness monitoring reduces uncertainties associated with the response of the system to restoration by answering questions derived from the conceptual model. Each ecosystem interaction in the model, or linkage between a process, structure, or function, represents a separate monitoring question. Monitoring answers these questions by systematically tracking indicators over time and comparing results to a predicted response. If an indicator does not develop as predicted, a contingency plan presents options and instructions for corrective action. More specific adaptive management responses are presented for each indicator in the strategy-specific monitoring tables in the following section of this document.

Although effectiveness monitoring is performed at the site scale, the information it generates can be used to inform decisions and make improvements at the program scale. Monitoring of primary, secondary, and tertiary indicators tests assumptions and reduces uncertainties associated with the conceptual models, enabling refinement of those models over time. In addition to improving existing sites, refined models can be used to make the next generation of restoration sites more effective.

The large spatial scale and long timeframe that characterize the monitoring of PSNERP restoration sites are also critical to programmatic improvement. Information from effectiveness monitoring across all PSNERP restoration sites can be used to reduce uncertainties about cumulative effects, while also tracking progress toward PSNERP program-scale objectives. The same information, collected over a long period as part of the broader assessment of nearshore restoration in Puget Sound, can be used to track and understand the response of the system to external factors such as climate change and land use patterns. This information can be used to adjust the objectives, design, and implementation of the next generation of restoration sites, as well as to adapt program objectives to changing conditions.

Table 3-1 shows the types of monitoring questions and contingency plans that apply to the three levels of PSNERP indicators. Contingency plans are presented as management responses to unfavorable monitoring results. These responses consist of information that must be considered to explain the unfavorable results, and potential corrective actions to help reverse them and move the system toward success. More specific adaptive

management responses are presented for each indicator in the strategy-specific monitoring tables in the following section of this document.

Although effectiveness monitoring is performed at the site scale, the information it generates can be used to inform decisions and make improvements at the program scale. Monitoring of primary, secondary, and tertiary indicators tests assumptions and reduces uncertainties associated with the conceptual models, enabling refinement of those models over time. In addition to improving existing sites, refined models can be used to make the next generation of restoration sites more effective.

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Table 3-1: PSNERP Monitoring Questions and Adaptive Management Responses.

Indicator Type	Monitoring Questions	Adaptive Management Response
Primary	• Do these management measures restore these target processes?	Considerations: ➢ Degree of stressor removal Potential actions: ➢ Further stressor removal
Secondary	• Do these management measures restore these target processes? • Do these restored processes generate the predicted structural responses?	Considerations: ➢ Degree of stressor removal; ➢ Other related metrics Potential actions: ➢ Further stressor removal; ➢ (Further) complementary management measures
Tertiary	• Do these restored processes generate the predicted structural responses? • Do these structural responses generate the predicted functional responses?	Considerations: ➢ All other metrics Potential actions: ➢ Further stressor removal; ➢ (Further) complementary management measures; ➢ Reassessment of conceptual model

4. Effectiveness Monitoring of Restoration Sites

Monitoring frameworks are presented in this section for each of the four PSNERP restoration strategies: river deltas, beaches, barrier embayments, and coastal inlets. Each strategy is described as a single system with a set of management measures and ecosystem processes to restore. This reflects the distinct way that nearshore processes structure the shoreline in each system, and is valid for the purpose of developing a monitoring framework. However, natural variation among restoration sites within each strategy will warrant slightly different approaches to monitoring.

It is assumed that as plans for the sites advance from current level of design (10%) to final design and construction, increasingly detailed monitoring plans will be developed for the sites. The indicators and metrics presented here for each strategy represent a comprehensive "shopping list" for monitoring restoration sites within that strategy. Monitoring plans developed for individual restoration sites are anticipated to vary from these according to site-scale conditions and requirements.

4.1 River Delta Strategy

4.1.1 Predicted Functional Outcomes

River deltas are formed where broad tidal surge plains meet marine waters. Most river deltas in Puget Sound have been extensively modified through urban and agricultural development and land use. Delta wetlands have been cut off from tidal flow by dikes, or eliminated through filling. Reduced tidal flushing and alluvial sediment input have prevented water and sediment from reaching marshes, causing subsidence, stalling of tidal channel formation and maintenance, and an overall decline in total delta shoreline length and complexity (Cereghino et al. 2012).

The restoration objective for river deltas is to remove dominant stressors to a degree that allows undegraded tidal flows and freshwater inputs necessary to support a full range of delta ecosystem processes, focusing on the reestablishment of complex wetlands (Figure 4-1). Restoration of tidal hydrology and freshwater input will lead to an enhanced tidal prism, as well as reconnection to natural flooding events. Increased flushing will change levels of organic carbon, oxygen, and nutrients in nearshore waters, and lead to the redevelopment of a salinity gradient appropriate to a diverse wetland system. Reconnection to freshwater input will lead to alluvial sediment and woody debris deposition and a gradual accretion of the marsh plain, which, together with the salinity gradient, will foster colonization by native marsh vegetation. Water flow and erosion will create tidal and distributary channel networks of varying complexity, which can deliver nutrients and detritus to nearshore ecosystems for use by invertebrates, fish, nearshore birds, and other species (Figure 4-2). Natural levees will develop alongside channels and can ultimately support riparian corridors (ESA 2011).

Following restoration of delta ecosystem processes, the system should develop redundant representation of delta ecosystem components, including tidal surge plain, tidal fresh and

oligohaline transition swamp, salt marsh, tidal flat, subtidal flat, distributary channel, tidal channel, and riparian forest. The restoration site should consist of well-connected large patches, and total shoreline length should increase (Cereghino et al. 2012).

Primary management measures include berm or dike removal or modification in order to restore tidal hydrology and freshwater input. Where primary management measures may be insufficient to achieve predicted structural and functional responses, they may be complemented as necessary by channel modification, topographic restoration, or revegetation.

4.1.2 Uncertainties

Response of the system to restoration:

- The degree of channel excavation for several restoration sites is based on the assumption that increased flow and tidal energy will allow channels to redevelop and sustain themselves naturally. If this assumption is incorrect, further channel excavation may be necessary.
- Increased tidal flushing may increase wave action, increasing erosion and turbidity, as well as flood risk to adjacent areas.
- Unanticipated impacts to adjacent landowners.
- Ongoing maintenance costs that will limit project effectiveness in the long run (e.g., cost of removing invasive species, cost of maintaining dikes/berms)

Cumulative effects, external factors, and constraints:

- In general, there is uncertainty as to whether the alluvial sediment supply available for accretion within the site will be sufficient to sustain marsh development. Restoration sites within the same shoreline process unit could create new sediment sinks, reducing this sediment supply.
- The effects of climate change introduce uncertainty, particularly about flooding frequency, magnitude, and duration, as well as the salinity gradient and resulting vegetation distribution. Sea level rise due to climate change could outpace accretion rates, preventing marsh vegetation adaptation.
- Watershed conditions, such as urban development and land use, may strongly affect sediment deposition and maintenance of water quality.
- Drainage on neighboring or upstream agricultural fields.
- Existing public access and use of area.

4.1.3 Monitoring Indicators, Metrics, and Adaptive Management Responses

Based on our conceptual model for the river delta strategy, Table 4-1 outlines the relationships between indicators of structural and functional response and associated monitoring metrics. The predicted response and timeframe for metrics is described in

general terms. Also listed are the primary processes that support proposed indicators – in other words, the indicator can develop according to its predicted response only if associated processes have been restored. This document is currently limited to an effectiveness monitoring framework for functional objectives. Site-specific constraints will also include actions necessary for protecting adjacent landowners, maintaining or replacing public uses of the site, and other factors to insure social acceptability. During future planning, engineering, and design phases, site-specific management constraints will be identified and addressed as part of the stakeholder involvement strategy, including the WDFW Restoration Pathway.

RIVER DELTA STRATEGY

Objective: Remove dominant stressors to a degree that allows undegraded tidal flows and freshwater inputs necessary to support a full range of delta ecosystem processes, focusing on the establishment of complex wetlands.

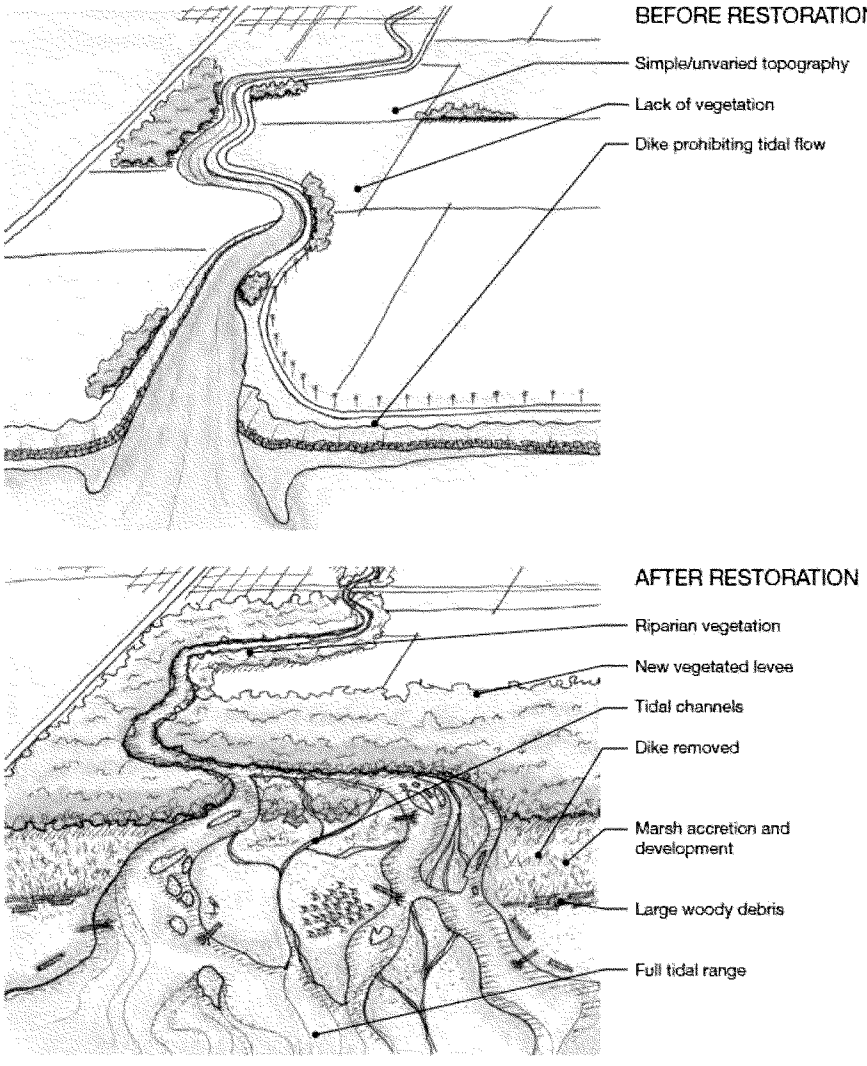

Figure 4-1: Example of a typical Puget Sound river delta depicting the degraded system prior to restoration, and the structural and functional responses of the system following restoration.

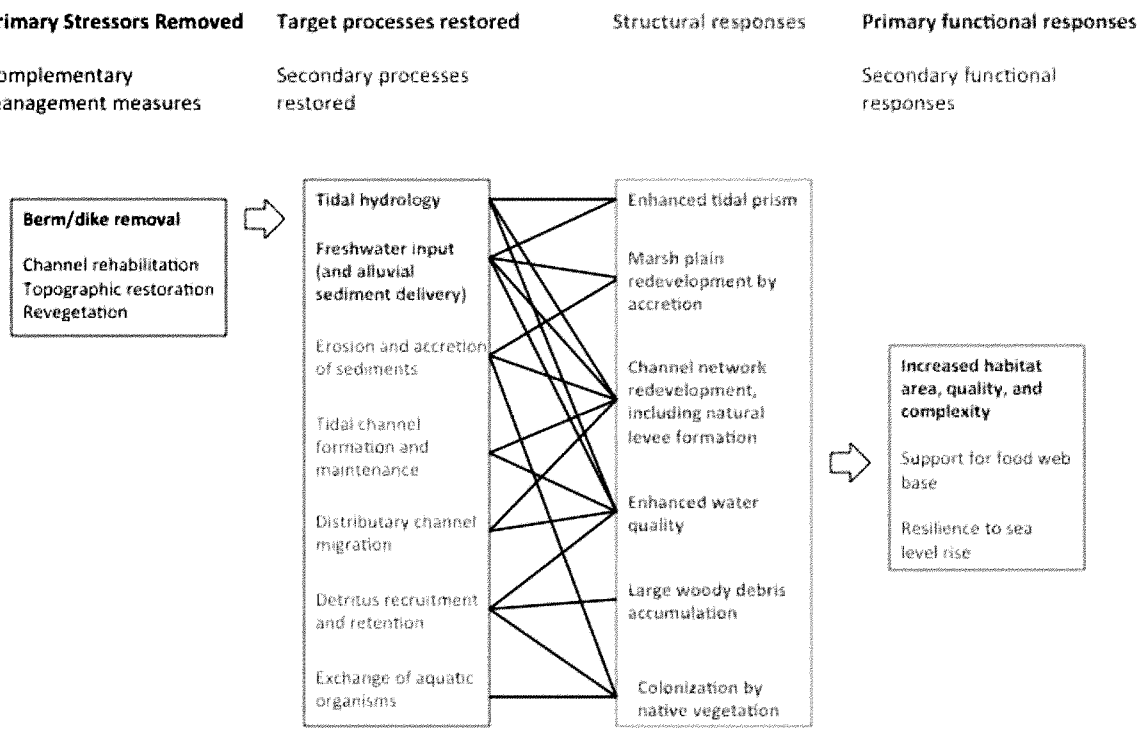

Figure 4-2: Conceptual model of management measures, restored processes, and structural and functional responses for the river delta strategy.

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Table 4-1: River Delta Strategy Monitoring Table.

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Primary Indicators					
Enhanced tidal prism	Tidal hydrology Freshwater input	- Water level (tidal elevations) - Water velocity - Inundation frequency, magnitude, duration, and area - Tidal prism (volumetric) - Salinity	Tidal prism will increase as tidal hydrology is restored to the delta. In most cases, tidal pattern should be the same inside and outside of the delta system. Natural flooding events will be restored, indicating restored connectivity to the river. Floodplain inundation will increase initially; then as marsh elevation increases, period of inundation will decline.	Immediately following restoration	Considerations: - Have stressors been removed to a degree sufficient to restore tidal hydrology and freshwater input? Potential actions: - Further stressor removal (berm/dike removal) as possible - Dredging of river channel

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			Salinity patterns will change consistent with increased tidal prism, restoring a salinity gradient to the estuary.		

Secondary Indicators

Marsh plain redevelopment by accretion	Freshwater input Erosion and accretion of sediments	- Site-scale topography and bathymetry - Local sediment accretion/ erosion rates	Accretion of alluvial sediments will outpace natural subsidence and lead to elevation gain. Site will obtain a shallow elevation gradient (slope) appropriate to marsh development.	Rate and distribution of sediment accretion will vary with the size of restored tidal opening and degree of connectivity to river. Smaller openings and less connectivity will result in more gradual, episodic, and local redistribution of sediments.	Considerations: - Local rate of sea level rise - Alluvial sediment supply Potential actions: - Increase tidal opening/connectivity (further stressor removal) - Adjust restoration phasing and design to increase accretion, (e.g., by adding wave

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					breaks or fill) - Remove/modify upstream dams or other hydraulic modifications.
Channel network redevelopment, including natural levee formation	Tidal hydrology Freshwater input Erosion and accretion of sediments Tidal channel formation and maintenance Distributary channel migration	- Dendritic tidal channel geometry measurements - Channel cross-section - Channel volume - Sediment structure (size and composition) - Site-scale topography and bathymetry - Local sediment accretion/	Restored tidal hydrology and freshwater input will increase flow of water and sediment through channels, leading to development of a channel network with density, complexity, and connectivity appropriate to phase of marsh development. Sedimentation patterns will change as a result of new distributary channel network, leading to a more	Rate of channel development depends on the degree to which tidal hydrology and freshwater input have been restored. Increased tidal hydrology will lead to faster development of larger channels. Actual channel migration could take decades, and is thus not an indicator of restoration success.	Considerations: - Have management actions interfered with existing drainage pattern? - Assumption: excavation of higher order channels will allow lower order channels to develop naturally Potential actions: - Filling of existing drainage channels - (Further) channel excavation

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
		erosion	diverse topography. Natural levees with coarser, better-drained soils will develop next to channels; these can eventually support riparian corridors. Channels should have the potential to migrate freely over time, though actual migration is not an indicator of restoration success.		- (Further) creation starter berms/levees
Enhanced water quality	Tidal hydrology Freshwater input Tidal channel formation and	- Dissolved organic carbon - Dissolved oxygen - pH	Increased flushing and connectivity will lead to enhanced water quality in terms of habitat conditions (i.e,. indicators directly relevant to biology),	Rapid change expected after restoration of tidal hydrology and freshwater input.	Considerations: - Water velocity and other indicators of flushing - Channel drainage network development

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
	maintenance Distributary channel migration Detritus recruitment and retention	- Temperature - Turbidity - Chlorophyll a - Sediment oxygen demand	including decreased temperature.		Potential actions: - Upstream watershed management - Applied studies to find causes of water quality problems
Large woody debris (LWD) accumulation	Detritus recruitment and retention	- Large wood composition, recruitment, and residence	Woody debris will be carried in naturally from restored tidal and freshwater flushing. Debris will contribute to the amount of organic carbon in the system, but should not interfere dramatically with flushing.	Potential for accumulation immediately following restoration of tidal hydrology; actual rate depends on flow and inundation rates.	Considerations: - Is tidal opening/connection to river large enough to allow passage of LWD? - Source of LWD Potential actions: - Increase size of tidal opening/connection to river - Removal and relocation of LWD from locations that cause blockage to

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					flow, particularly following weather and/or inundation events
Colonization of native vegetation	Erosion and accretion of sediments Detritus recruitment and retention Exchange of aquatic organisms	- Distribution and abundance of native plants - Distribution and abundance of invasive plants	Vegetation assemblage will develop and change based on restored salinity and topography regime, (e.g., mudflat, tidal marsh, riparian, woody). In general, vegetation should transition from intertidal emergent vegetation to scrub-shrub and forested wetland. Facilitated by internally connected system of shifting distributaries and resulting	Dependent on rate of marsh surface elevation increase; anticipated to be detectable within 5 years of reaching appropriate elevations.	Considerations: - Size and configuration of tidal opening (e.g., one large hole vs. several small holes) - Potential barriers to organism exchange - Marsh plain elevation and topography - Water quality metrics - Invasive plant colonization Potential actions: - Increase tidal opening/connection

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			unconstrained movement of organisms and nutrients.		to river - Adjust restoration phasing and design to increase accretion to colonization levels - Revegetation - Invasive plant removal

Tertiary Indicators

Increased habitat area, quality, and complexity	ALL	- Distribution and extent by habitat type - Habitat quality rating based on soil, water, diversity measurements collected as part of this monitoring plan - Shoreline length and	The system should develop redundant representation of the full range of delta ecosystem components, including river floodplain, tidal fresh and oligohaline transition swamp, salt marsh, tidal flat, subtidal flat, distributary	Extent and quality of habitats will respond gradually following establishment of all structural responses.	Considerations: - Analyze all available monitoring data to determine whether result is due to restoration or external factors Potential actions: - Assess relative to all other monitoring metrics – if processes

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
		complexity - Landscape connectivity and patchiness	channel, tidal channel, and riparian forest. Development of complex channel networks will result in enhanced shoreline length and complexity. The site should be formed of contiguous large patches that are well connected to each other and to the surrounding riverine, terrestrial, and marine landscape.		have been restored but habitat function has not, consider change to conceptual model

4.2 Beach Strategy

4.2.1 Predicted Functional Outcomes

Historically, 50% of the Puget Sound shoreline was composed of beach systems. Concurrent with coastal development, shoreline armoring has been built to protect private property on bluffs and banks from erosion. Armoring has led to the alteration of more than 500 km of bluff-backed shore, which has cut off the sediment supply that maintains down-drift beaches (Cereghino et al. 2012). Armoring also increases potential for loss of beach area and elevation over time (Johannessen and MacLennan 2007), which can decrease resilience to sea level rise (Pethick 2001). By removing or preventing colonization of vegetation and inhibiting wrack and woody debris accumulation, armoring can reduce beach productivity and diversity. Relative to river deltas, barrier embayments, and coastal inlets, degraded beach processes have a greater potential to impact nearshore ecosystems beyond the geographical limits of the altered beaches themselves.

The restoration objective for beaches is to remove or modify barriers to the movement of sediment from sources (bluffs) to sinks (beaches) to a degree that allows the full range of beach processes (Figure 4-3). Figure 4-4 outlines our conceptual model of the relationship between stressor removal, restored processes, and predicted structural and functional responses. Restoration of sediment supply and transport processes is expected to reinitiate bluff toe erosion and increase sediment delivery to down-drift beaches. Restored sediment input and erosion processes will redevelop the beach profile to its former configuration, and the beach will develop a well-sorted, natural sediment size profile. Both site and adjacent beach area should increase. Wrack, large woody debris, and native vegetation should accumulate and develop at the bluff-beach interface. In general, the landward portion of the nearshore zone should provide riparian functions, as well as a historical quantity and quality of ground surface freshwater inputs. This, together with increased overhanging vegetation, will contribute to enhanced sediment moisture content and cooler nearshore waters (ESA 2011; Cereghino et al. 2012).

The primary management measure for beach restoration is armor removal or modification in order to restore sediment supply from feeder bluffs. Groin removal is also a primary measure where cross-shore structures impound sediment and starve down-drift beaches. Where primary management measures are insufficient to achieve predicted structural and functional responses, they may be complemented as necessary by topographic restoration and revegetation.

4.2.2 Uncertainties

Response of the system to restoration:

- The timing of the system's response to armor removal is highly uncertain due to lack of empirical data on sediment delivery rates from natural beach systems or armoring removal management measures on Puget Sound shorelines. Benefits of armor removal may occur over a period of decades as opposed to years, relying on episodic storm events to trigger a release of sediment.
- The rate of sediment supply necessary to sustain a particular beach is unknown. Partial, rather than full restoration may be insufficient to achieve objectives of restoring sediment supply.
- Armor removal, unlike other management measures, is difficult to apply incrementally, and may be less reversible, making contingency planning more difficult.

Cumulative effects, external factors, and constraints:

- In general, beach dynamics are driven largely by external factors. Local geology, wave exposure, topography, tidal range, climate, weather events, mass-wasting events, and vegetation all contribute to shaping the beach. Thus, monitoring of structural and functional indicators is less valuable for understanding system dynamics than monitoring these driving factors.
- Loss of beach due to sea level rise is difficult to estimate due to lack of understanding of the differences between current and historical beach structure.
- Bluff erosion which poses a potential risk to infrastructure located adjacent to target restoration sites.

4.2.3 Monitoring Indicators, Metrics, and Adaptive Management Responses

Based on our conceptual model for the beach strategy, Table 4-2 outlines the relationships between indicators of structural and functional response and associated monitoring metrics. The predicted response and timeframe for metrics is described in general terms. Also listed are the primary processes that support proposed indicators – in other words, the indicator can develop according to its predicted response only if associated processes have been restored.

BEACH STRATEGY

Objective: Remove or modify barriers to the movement of sediment from sources (bluffs) to sinks (beaches) to a degree that allows the full range of beach processes.

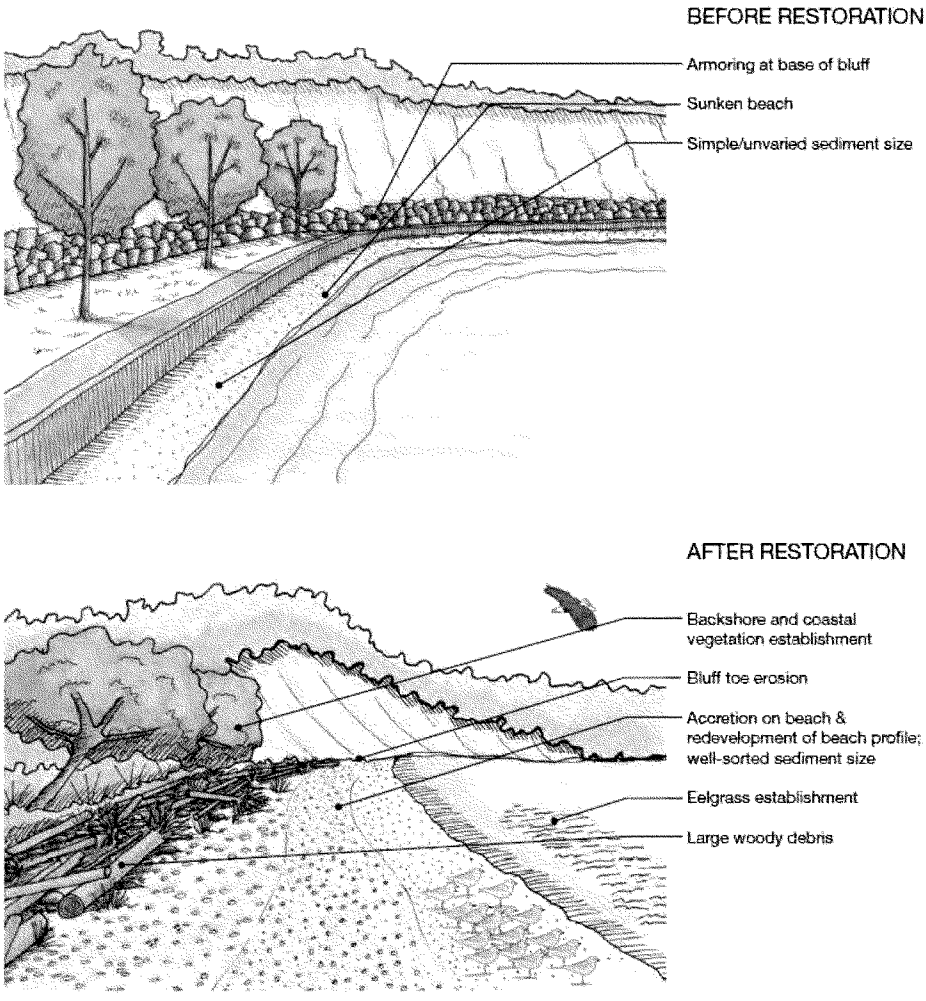

Figure 4-3: Example of a typical Puget Sound beach depicting the degraded system prior to restoration, and the structural and functional responses of the system following restoration.

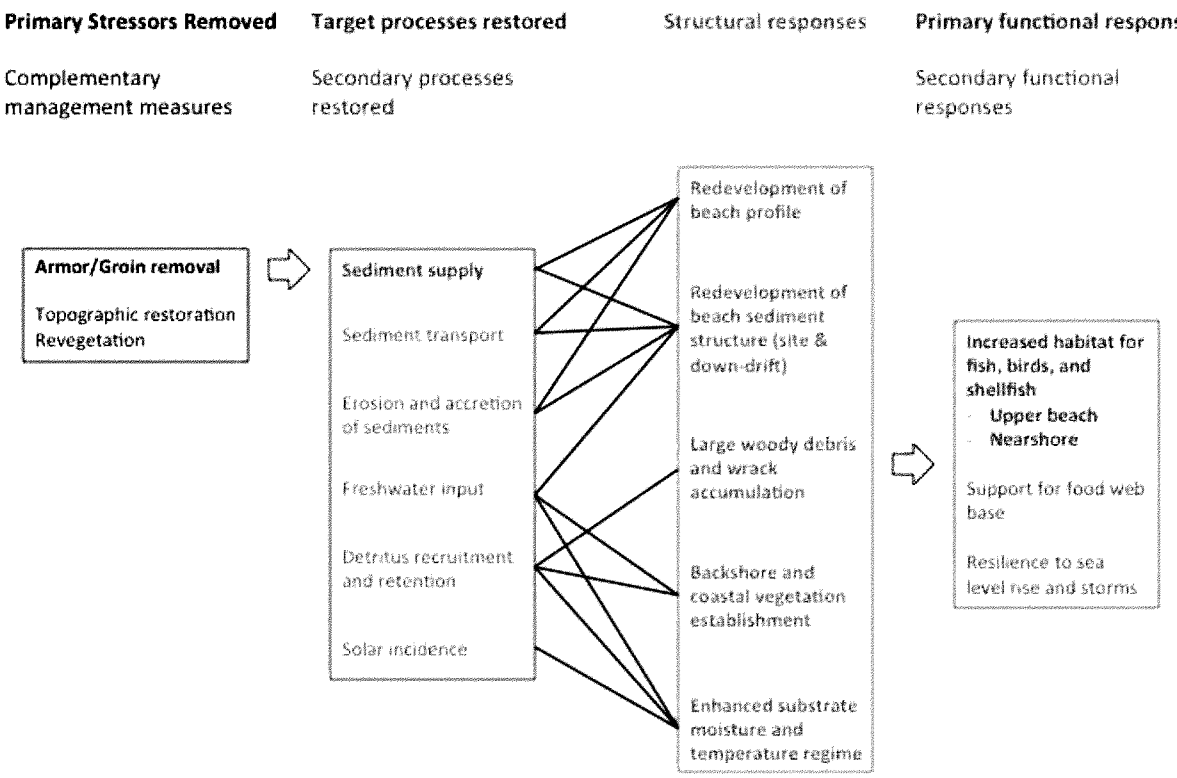

Figure 4-4: Conceptual model of management measures, restored processes, and structural and functional responses for the beach strategy.

Table 4-2: Beach Strategy Monitoring Table.

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Primary Indicators					
Bluff recession	Sediment supply	- Topographic evidence of sediments accreted at base of bulkhead-removal bluff - Bluff toe erosion rate - Occurrence of landslide events - Bluff recession rate	Erosion of bluff toe will accelerate until new dynamic equilibrium is established. Over time, it will slow to the rate of reference/unarmored sites. Bluff recession may occur, but rate is dependent on external factors such as precipitation events.	Erosion of bluff toe will accelerate immediately following armor removal Slowing to equilibrium rate anticipated on the order of 15 to 30 years	Considerations: - Reassess geomorphic characterization of feeder bluff as sediment source - Reassess hypotheses regarding the rate of sediment delivery or of beach response Potential actions: - Further armor removal as possible - Beach nourishment
Secondary Indicators					
Redevelopment of beach profile (site & down-drift)	Sediment supply Sediment transport	- Beach topography profile - Accretion rates on	Upper beach should grade to its former configuration (determined by reference/unarmored beach) upon	Natural beach profile restored in approximately one year Timing of effects	Considerations: - Erosion and accretion rates - Timing and exposure to

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
	Erosion and accretion of sediments	down-drift beaches, within littoral drift cell	exposure to wave energy.	on down-drift beaches depends on rates of wind- and wave-driven sediment transport	wind and wave energy Potential actions: - Beach nourishment
Redevelopment of sediment structure (site & down-drift)	Sediment supply Sediment transport Erosion and accretion of sediments Freshwater input	- Sediment size and composition onsite - Sediment size and composition on down-drift beaches, within littoral drift cell	Beach should develop well-sorted, natural sediment size profile similar to reference beach, (e.g., pebble/sand beach face with sandy backshore.)	Response timing will depend on storms and mass-wasting events. Timing of effects on down-drift beaches depends on rates of wind- and wave-driven sediment transport	Considerations: - Erosion and accretion rates - Timing and exposure to wind and wave energy Potential actions: - Beach nourishment
Large woody debris (LWD) and wrack accumulation	Detritus recruitment and retention	- Wrack composition and amount - Large wood composition, recruitment, and residence	Large woody debris and wrack should accumulate at bluff-beach interface. This includes driftwood accumulations and active large woody debris recruitment from shallow	Within one year Exact timing depends on rates of wind- and wave-driven transport of LWD and wrack, as well as beach profile	Considerations: - Beach profile steepness - Source of LWD Potential actions:

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			landslides.	response	- Driftwood placement
Backshore and coastal vegetation establishment	Freshwater input Detritus recruitment and retention	- Distribution and abundance of native plants - Distribution and abundance of invasive plants - Area covered by over-hanging marine riparian vegetation	Native vegetation should develop at the bluff-beach interface (backshore). Area receiving benefits of overhanging marine riparian vegetation (shade) should grow as vegetation is established.	Some vegetation should begin to establish itself within one year Exact timing depends on conditions of existing vegetation (pre-restoration)	Considerations: - LWD and wrack accumulation - Sediment structure - Invasive plant colonization Potential actions: - Revegetation - Invasive plant removal
Enhanced substrate moisture and temperature regime	Freshwater input Detritus recruitment and retention Solar incidence	- Temperature at high tidal elevation - Sediment moisture at high tidal elevation	Overhanging vegetation will decrease overall solar incidence, decreasing average water temperature (particularly below overhanging vegetation). Sediment moisture	Response rate will follow rate of establishment of over-hanging vegetation	Considerations: - Establishment of overhanging vegetation - Weather and climate conditions - Sediment size (drainage)

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			content should increase as a result of slowed evaporation and restored freshwater input, where applicable.		Potential actions: - Revegetation - Invasive plant removal

Tertiary Indicators

Increased habitat area and quality	ALL	- Areal extent of backshore, intertidal, and nearshore habitat - Habitat quality rating based on sediment, water, vegetation measurements collected as part of this monitoring plan	Upper intertidal beach area should increase with armor removal. Adjacent and down-drift beaches and associated nearshore habitats within the drift cell should increase in area with the restoration of sediment supply. This includes habitat with substrate size appropriate for potential forage fish spawning.	Area lost due to placement loss will be gained back immediately following armor removal. Extent and quality of other areas will respond gradually following establishment of all structural responses. Difficult to predict when down-drift habitats may experience benefits.	Considerations: - Analyze all available monitoring data to determine whether result is due to restoration or external factors Potential actions: - Assess relative to all other monitoring metrics – if processes have been restored but habitat function has not, consider change to conceptual model

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4.3 Barrier Embayment Strategy

4.3.1 Predicted Functional Outcomes

Structures and functions of barrier embayments are affected by the condition of the beach system that sustains the barrier, and are increasingly sediment-starved due to shoreline armoring. Transportation infrastructure built on top of barrier features can prevent natural migration and increase beach loss from erosion. Filling or diking for development has disconnected many embayments from tidal influence, and may cause the embayment opening to close completely.

The restoration objective for barrier embayments is to remove dominant stressors to restore sediment supply and transport processes to littoral drift cells where bluff erosion sustains barrier beaches that form barrier embayments, and to remove dominant stressors to restore the tidal processes found therein (Figure 4-5). Figure 4-4 outlines our conceptual model of the relationship between stressor removal, restored processes, and predicted structural and functional responses. Following removal of stressors to tidal hydrology, tidal prism will increase incrementally. This will result in enhanced tidal elevations and increased flushing, as well as the reestablishment of a salinity gradient throughout the embayment. Increased tidal flow through channels will lead to the development of a channel network and associated diverse topography. Increased flow will also improve levels of organic carbon, oxygen, and nutrients in embayment waters, especially in lagoons that are reconnected to tidal influence by the restoration action. Sediments delivered by tidal channels will lead to a gradual accretion of the marsh plain, which, together with the unconstrained flow of water and organic material through those channels, will foster colonization by native marsh vegetation. Restored sediment and transport processes will lead to sediment deposition within the embayment and along the shoreline, increasing the extent of barrier beach. Restored littoral processes will rework sediment in the embayment and barrier feature, depositing sediment within the embayment opening until equilibrium is achieved between tidal forces and wave action (ESA 2011).

Following restoration of barrier embayment ecosystem processes, the system should develop redundant representation of barrier embayment ecosystem components including, where historically present, stream delta or ponds, tidal flats, salt marsh, channels, tidal delta, beach berm, beach face, and low tide terrace. The restoration site should consist of one well-connected large patch, and total shoreline length should increase (Cereghino et al. 2012).

Primary management measures include berm or dike removal or modification to restore tidal hydrology where embayment topography is intact, or topographic restoration (fill removal) where an embayment has been filled. Armor or groin removal is another primary management measure to restore sediment supply to a barrier feature, as well as removal of infrastructure that hinders natural inlet channel form and movement. Where primary management measures are insufficient to achieve predicted structural and functional responses, they may be complemented as necessary by hydraulic modification or channel rehabilitation.

4.3.2 Uncertainties

Response of the system to restoration:

- The effect of restoration on flooding risk is uncertain. Removal of dams and other barriers to tidal hydrology may increase flood risk to non-acquired properties. At the same time, removal of such barriers could reduce the extent of fluvial flooding during high creek flows.
- Restoration could necessitate shore protection of non-acquired properties due to increased local erosion and channel migration.
- As with river deltas, the degree of channel excavation for several restoration sites is based on the assumption that increased flow and tidal energy will allow channels to redevelop and sustain themselves naturally. If this assumption is incorrect, further channel excavation may be necessary.
- Though marsh is a natural endpoint landform for this strategy, the rate at which the marsh surface topography will evolve over time is uncertain.
- Wave action could naturally build a sill which would prevent full drainage and tidal flushing, reducing the depth of the embayment opening or closing it entirely.

Cumulative effects, external factors, and constraints:

- Landward retreat of wetlands in response to sea level rise may be constrained by land use. This uncertainty is tied to the local rate of sea level rise.
- Changes to the watershed outside of the restoration site, such as urban development, could change the effect of restoration actions on embayment area and edge density.
- As with river deltas, there is uncertainty as to whether the sediment supply available for accretion within the site will be sufficient to sustain marsh development. Restoration sites within the same shoreline process unit could also create new sediment sinks, reducing this sediment supply.

4.3.3 Monitoring Indicators, Metrics, and Adaptive Management Responses

Based on our conceptual model for the Barrier Embayment strategy, Table 4-3 outlines the relationships between indicators of structural and functional response and associated monitoring metrics. The predicted response and timeframe for metrics is described in general terms. Also listed are the primary processes that support proposed indicators – in other words, the indicator can develop according to its predicted response only if associated processes have been restored.

BARRIER EMBAYMENT STRATEGY

Objective: Remove dominant stressors to restore sediment supply and transport processes to littoral drifts cells where bluff erosion sustains barrier beaches that form barrier embayments, and to removed dominant stressors to restore the tidal processes found therein.

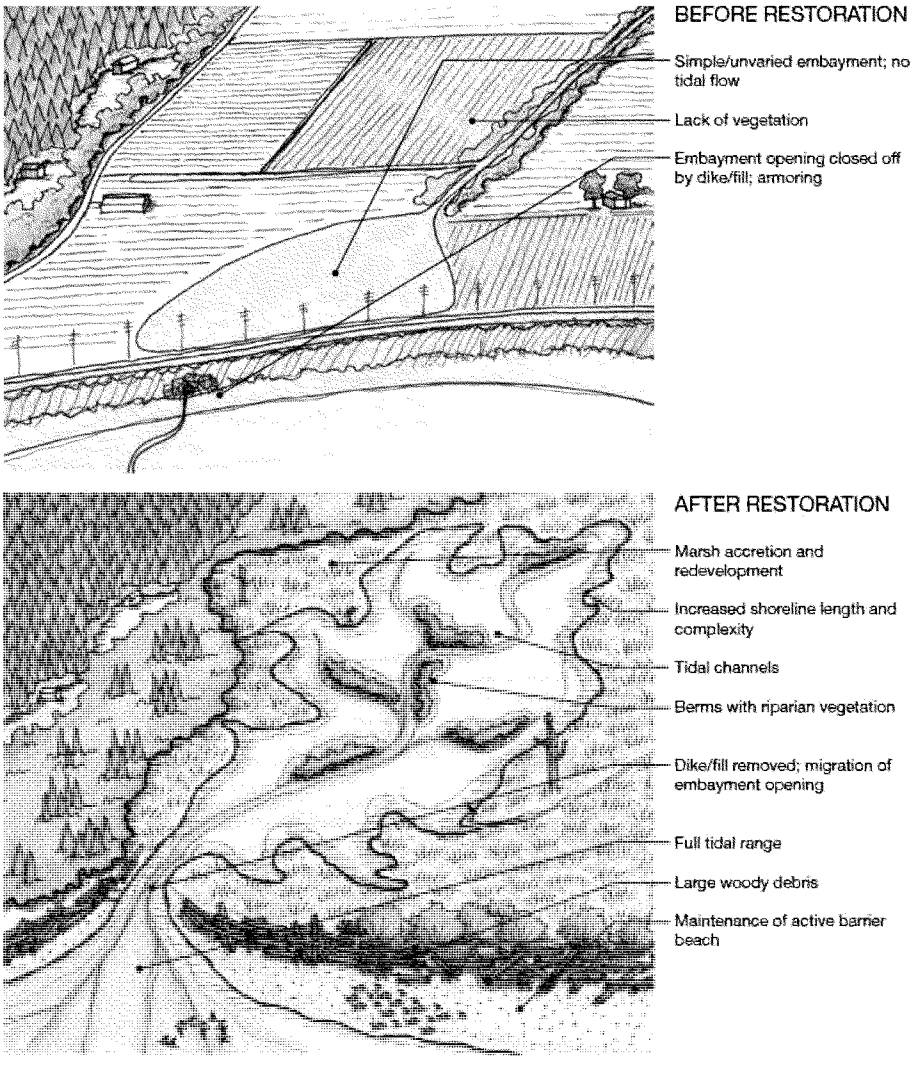

Figure 4-5: Example of a typical Puget Sound barrier embayment depicting the degraded system prior to restoration, and the structural and functional responses of the system following restoration.

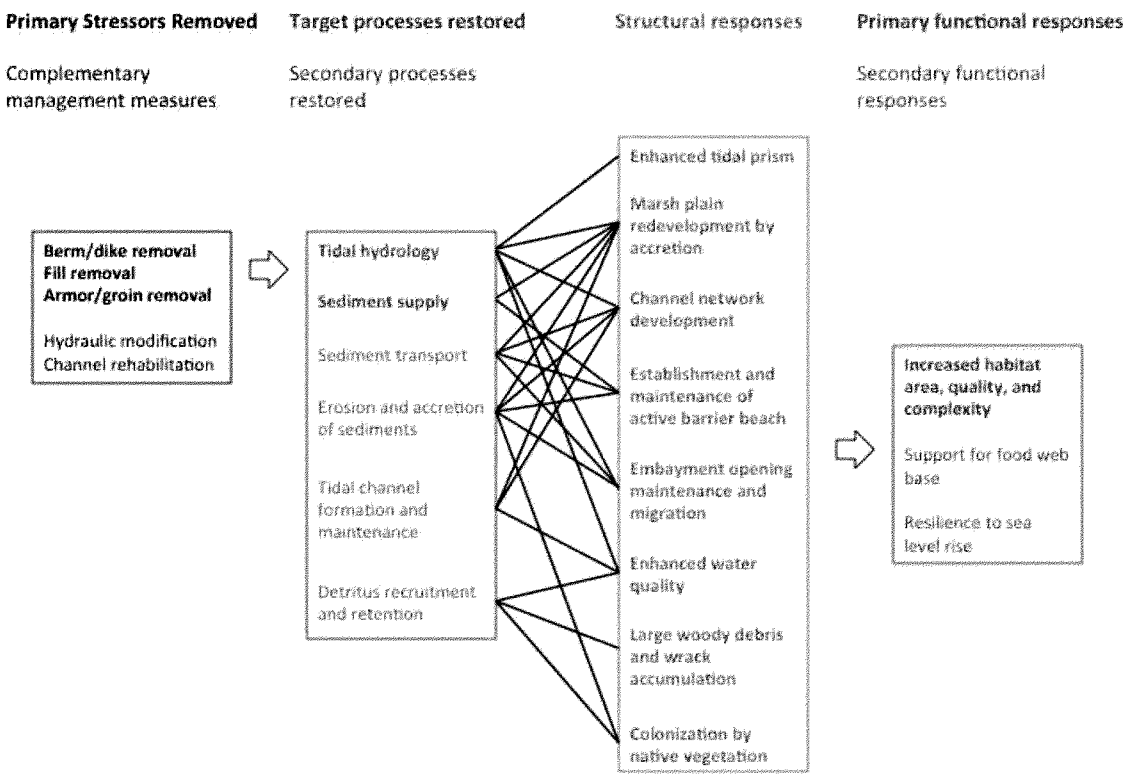

Figure 4-6: Conceptual model of management measures, restored processes, and structural and functional responses for the Barrier Embayment strategy.

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Table 4-3: Barrier Embayment Strategy Monitoring Table.

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Primary Indicators					
Enhanced tidal prism	Tidal hydrology	- Water level (tidal elevations) - Water velocity - Tidal prism (volumetric) - Salinity	Tidal prism will increase incrementally, resulting in enhanced tidal elevations, increased water velocity/flushing, and reestablishment of a salinity gradient throughout the embayment.	Immediately following restoration	Considerations: - Have stressors been removed to a degree sufficient to restore tidal hydrology and freshwater input? - Calculation of full, restored tidal prism and associated size of embayment opening Potential actions: - Further stressor removal (berm/dike removal) as possible
Bluff recession	Sediment supply	- Changes in topographic evidence of sediments accreted at base	Armor removal will restore sediment supply from feeder bluff to barrier feature by way of	Timing depends on rates of wind- and wave-driven	Considerations: -Reassess geomorphic characterization of

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
		of bulkhead-removal bluff - Bluff toe erosion rate - Occurrence of landslide events - Bluff recession rate	littoral transport. In sites without armor removal, sediment supply is largely external to the site.	sediment transport.	feeder bluff as sediment source Potential actions: -Further armor removal as possible -Beach nourishment to restore functioning intertidal beach and supply for barrier feature

Secondary Indicators

Embayment opening maintenance and migration	Tidal hydrology Sediment transport Erosion and accretion of sediments	- Cross-section and bathymetry of inlet/channel opening	Larger (restored) embayment opening will lead to larger tidal prism and improved flushing, which will in turn increase the likelihood that the embayment remains open. Erosion and migration of embayment opening are		Considerations: - Assumption: Embayment opening will naturally resize to accommodate tidal prism - Impounded sediments inside the

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			also possible, but not indicators of restoration success. Over time, littoral processes will rework sediment in the embayment and barrier feature, depositing sediment within the excavated opening (as applicable) to develop equilibrium between tidal forces and wave action. Wave action could naturally build a sill which would prevent full drainage and tidal flushing, reducing the depth of the embayment opening		embayment - Sediment source outside the embayment - Water velocity/flushing sufficient to maintain opening - Manmade structures on barrier preventing natural migration Potential actions: - (Further) removal of fill/impounded sediments - (Further) removal of structures on barrier/across embayment opening

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Establishment and maintenance of active barrier beach	Sediment supply Sediment transport Erosion and accretion of sediments	- Topography and profile of barrier - Accretion rates on barrier - Sediment size	Substantial sediment deposition within the restored embayment and along the shoreline due to increased tidal currents into and out of the embayment (littoral transport) will result in an increase of barrier beach extent and size. Over time, littoral processes will rework the sediment, rebuilding the beach berm. Beach profile should become wider and shallower, allowing more accretion and overwash of coarser sediments supplied by feeder bluffs.	Timing depends on rates of wind- and wave-driven sediment transport as well as littoral transport rates within the embayment.	Considerations: - Sediment supply - Erosion and accretion rates - Timing and exposure to wind and wave energy - Manmade structures on barrier preventing natural migration Potential actions: - Beach nourishment - Regrading of beach profile
Channel network redevelopment	Tidal hydrology Sediment	- Dendritic tidal channel geometry	Restored tidal hydrology will increase flow of water and sediment through channels,	Rate of evolution of tidal drainage network is	Considerations: - Have management actions interfered

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
	transport Erosion and accretion of sediments Tidal channel formation and maint-enance	measurements - Channel cross-sections - Panne and pond size distribution relative to channel network - Sediment structure (size and composition) - Site-scale topography and bathymetry - Local sediment accretion/erosi on	leading to development of a channel network with density, complexity, and connectivity appropriate to phase of marsh development. Increased channel complexity will lead to overall shoreline lengthening. Sedimentation patterns will change as a result of new channel network, leading to a more diverse topography. Natural levees with coarser, better-drained soils may develop next to channels. Initially ponding will occur, but over time sediments will fill in ponds and natural drainage will occur through channels. New drainage network should drain through	directly related to sedimentation rate. Ponding will retard site's evolution, but should only occur for 1-2 years before natural drainage takes over.	with existing drainage pattern? - Assumption: excavation of higher order channels will allow lower order channels to develop naturally - Empirical relationships between tidal prism and channel size - Effect of sidecast berms created to resemble natural levees Potential actions: - Filling of existing drainage channels - (Further) channel excavation

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			barrier breach/embayment opening.		- (Further) fill removal, especially in the case of extended ponding - (Further) creation of starter berms/levees
Marsh plain redevelopment by accretion	Tidal hydrology Sediment supply Sediment transport Erosion and accretion of sediments Tidal channel formation and maint-enance	- Site-scale topography and bathymetry - Local sediment accretion/erosi on rates	Accretion of sediments delivered by tidal channels via littoral transport will outpace natural subsidence and lead to elevation gain. Erosion in tidal channels and deposition in backwater areas will result in a shallow elevation gradient (slope) appropriate to marsh development. Marsh is the natural endpoint landform; however, how marsh surface topography will evolve over time is	Rate and distribution of sediment accretion will vary with the size of restored tidal opening and. Smaller openings and less connectivity will result in more gradual, episodic, and local redistribution of sediments. Rate also depends on	Considerations: - Local rate of sea level rise - Sediment supply - Tidal channel network development Potential actions: - Increase tidal opening (further stressor removal) - Adjust restoration phasing and design

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
			uncertain. Increased tidal flow and wave energy will result in increased topographic complexity within tidelands.	sediment supply, which is often external to the site. Rate at which marsh surface elevation will increase is uncertain.	to increase accretion, (e.g., by adding wave breaks or fill)
Enhanced water quality	Tidal hydrology Tidal channel formation and maint-enance Detritus recruitment and retention	- Dissolved organic carbon - Dissolved oxygen - pH - Temperature - Turbidity - Chlorophyll a - Sediment oxygen demand	Increased flushing will lead to enhanced water quality in terms of habitat conditions (i.e., indicators directly relevant to biology), including decreased temperature. Particularly relevant in lagoons or other features that were fully or partially enclosed prior to restoration and have been reconnected to tidal influence.	Rapid improvement expected after restoration of tidal hydrology.	Considerations: - Water velocity and other indicators of flushing - Channel drainage network development Potential actions: - Active management such as baffles,

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					aerators, etc. - Applied studies to find causes of water quality problems
Large woody debris (LWD) and wrack accumulation	Detritus recruitment and retention	- Wrack composition and amount - Large wood composition, recruitment, movement, and residence	Woody debris will be carried in naturally from restored tidal flushing. Debris will contribute to the amount of organic carbon in the system, but should not interfere dramatically with flushing. LWD should accumulate inside barrier berm from increased overwashing event.	Potential for accumulation immediately following restoration of tidal hydrology; actual rate depends on flow rates and weather events (overwashing).	Considerations: - Is embayment opening large enough to allow passage of LWD? - Source of LWD - Beach profile steepness Potential actions: - Increase size of embayment opening - Regrading of beach profile - Removal and relocation of LWD

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					from locations that cause blockage to flow, particularly following weather events
Colonization by native vegetation	Erosion and accretion of sediments Detritus recruitment and retention	- Distribution and abundance of native plants by type - Species richness - Distribution and abundance of invasive plants	Vegetation assemblage will develop and change naturally based on restored salinity and topography regime. Colonization is tied to marsh plain redevelopment. However, some areas of the site may remain unvegetated naturally.	Dependent on rate of marsh surface elevation increase; anticipated to be detectable within 5 years of reaching appropriate elevations.	Considerations: - Disruption by management measures, (e.g., removal of fill) - Potential barriers to organism exchange - Marsh plain elevation and topography - Water quality metrics - Invasive plant colonization Potential actions:

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					- Revegetation - Control of invasive plants, particularly in areas not affected by tidal inundation

Tertiary Indicators

Increased habitat area, quality, and complexity	ALL	- Distribution and extent by habitat type - Intertidal and shallow subtidal area - Shoreline length and complexity - Habitat quality rating based on sediment, water, vegetation measurements collected as part	Gentle topography and salinity gradient of site will allow full gradient of habitats to be established. A wider intertidal area and lower wave reflection, as well as coarser sediment size, will create conditions suitable for fish spawning and bird use, as well as salmonid rearing. The site should develop redundant representation of the full	Area lost due to placement loss, including from armoring as well as manmade structures on the barrier feature, will be gained back immediately following armor removal. Extent and quality of other areas will respond	Considerations: - Analyze all available monitoring data to determine whether result is due to restoration or external factors Potential actions: - Assess relative to all other monitoring metrics – if processes have been restored but habitat function has not, consider change to conceptual

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
		of this monitoring plan - Landscape connectivity and patchiness	range of barrier embayment ecosystem components including stream deltas or ponds, tidal flats, salt marsh, channels, tidal delta, beach berm, beach face, and low tide terrace where historically present. The site should be formed of a contiguous large patch that is well connected to adjacent terrestrial and marine landscapes.	gradually following establishment of all structural responses.	model

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4.4 Coastal Inlet Strategy

4.4.1 Predicted Functional Outcomes

Like barrier embayments, coastal inlets are defined by an area protected from wave energy by landscape configuration, and provide sheltered conditions for aquatic species. Coastal inlets differ from barrier embayments in the more perennial input of freshwater in the inlets. In addition, though a barrier feature may be present, it is less important to restoration objectives, which are more focused on bringing tidal and freshwater flushing back into the inlet system. Thirty-eight percent of historically mapped coastal inlets in Puget Sound have been modified from natural shoreline (Cereghino et al. 2012). These features have been filled or diked for development, disconnecting them from natural freshwater and tidal inputs.

The restoration objective for coastal inlets is to remove dominant stressors to a degree that allows undegraded tidal flows and freshwater inputs necessary to support a full range of coastal inlet ecosystem processes (Figure 4-7). Figure 4-8 outlines our conceptual model of the relationship between stressor removal, restored processes, and predicted structural and functional responses. Following restoration of tidal hydrology, tidal flushing will increase, and the inlet will maintain an opening appropriate to the size of the restored tidal prism. Restored flow through tidal channels will mobilize sediments and import water, while creating a complex network of more distinct, larger tidal channels. Increased water velocity will also excavate a network of dendritic marsh channels, increasing marsh area and complexity. Increased flushing through these channels will improve levels of organic carbon, oxygen, and nutrients in nearshore waters, and lead to the redevelopment of a salinity gradient throughout the inlet. Woody debris will be imported naturally and contribute to the biomass and structure of organic material near shore, and vegetation assemblages should recolonize according to the restored salinity and topography regime. In particular, floral and faunal assemblages should change from freshwater to saltwater marsh upon reconnection to tidal flushing (ESA 2011).

Following restoration of coastal inlet ecosystem processes, the system should develop redundant representation of coastal inlet ecosystem components including, where historically present, creek delta with swamp, scrub-shrub, marsh, tide flat, and channels. The restoration site should consist of well-connected large patches, and total shoreline length should increase (Cereghino et al. 2012).

Primary management measures include berm or dike removal where inlet topography is largely intact or topographic restoration (fill removal) where an inlet has been filled. Where primary management measures are insufficient to achieve predicted structural and functional responses, they may be complemented as necessary by hydraulic modification or revegetation.

4.4.2 Uncertainties

Response of the system to restoration:

- The effect of restoration on flooding risk is uncertain. Removal of dams and other barriers to tidal hydrology may increase flood risk to non-acquired properties. At the same time, removal of such barriers could reduce the extent of fluvial flooding during high creek flows.
- Restoration could necessitate shoreline armoring of non-acquired properties due to increased local erosion and channel migration.
- As with river deltas, the degree of channel excavation for several restoration sites is based on the assumption that increased flow and tidal energy will allow channels to redevelop and sustain themselves naturally. If this assumption is incorrect, further channel excavation may be necessary.

Cumulative effects, external factors, and constraints:

- Landward retreat of wetlands in response to sea level rise may be constrained by land use. This uncertainty is tied to the local rate of sea level rise.
- Changes to the watershed outside of the site, such as urban development, could change the effect of restoration actions on inlet area and edge density.

4.4.3 Monitoring Indicators, Metrics, and Adaptive Management Responses

Based on our conceptual model for the Coastal Inlet strategy, Table 4-4 outlines the relationships between indicators of structural and functional response and associated monitoring metrics. The predicted response and timeframe for metrics is described in general terms. Also listed are the primary processes that support proposed indicators – in other words, the indicator can develop according to its predicted response only if associated processes have been restored.

COASTAL INLET STRATEGY

Objective: Remove dominant stressors to a degree that allows undegraded tidal flows and freshwater inputs necessary to support a full range of coastal inlet ecosystem processes.

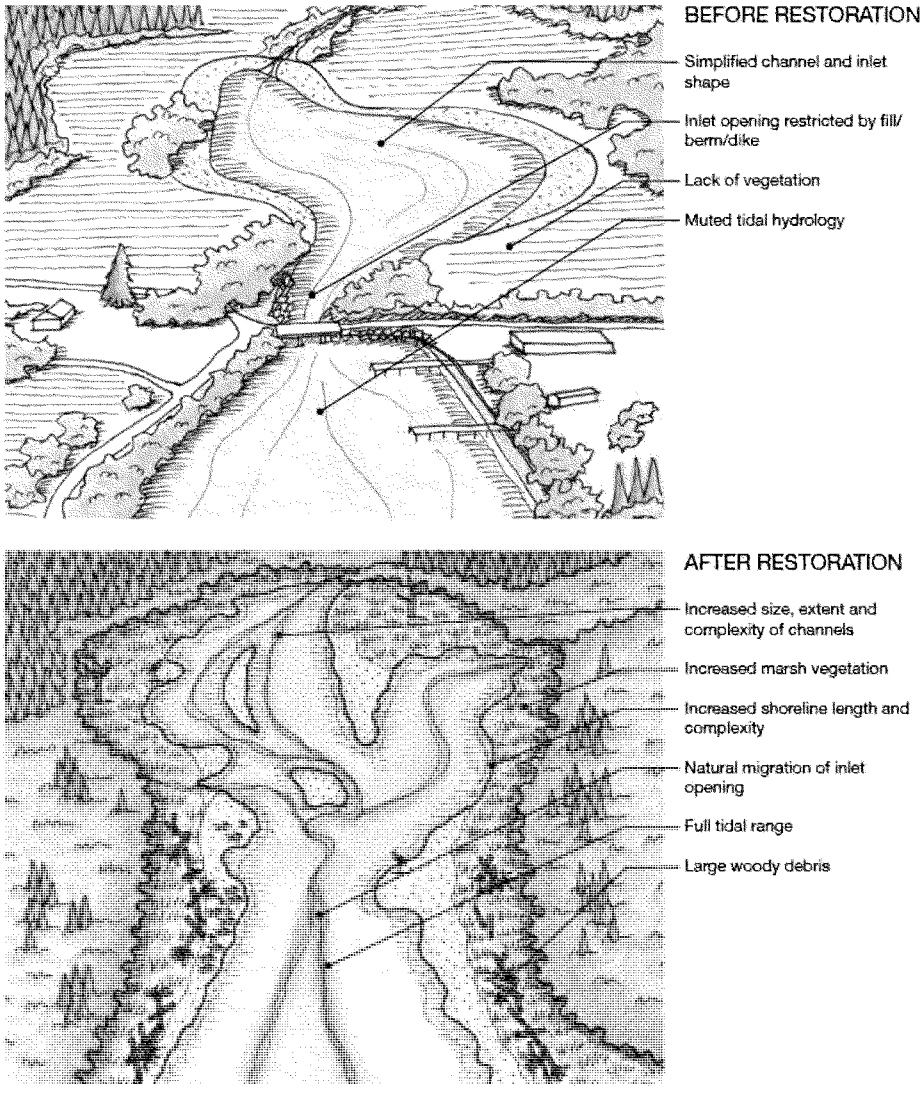

Figure 4-7: Example of a typical Puget Sound coastal inlet depicting the degraded system prior to restoration, and the structural and functional responses of the system following restoration.

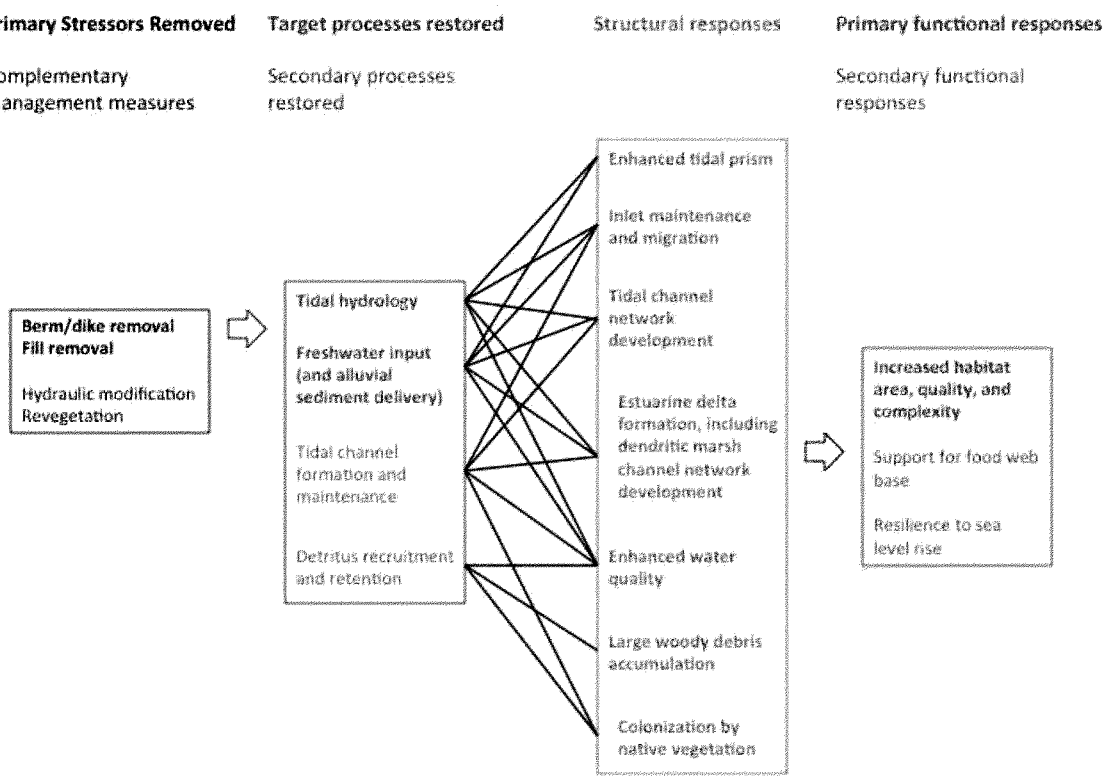

Figure 4-8: Conceptual model of management measures, restored processes, and structural and functional responses for the Coastal Inlet strategy.

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Table 4-4: Coastal Inlet Strategy Monitoring Table.

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Primary Indicators					
Enhanced tidal prism	Tidal hydrology Freshwater input	- Water level (tidal elevations) - Water velocity - Tidal prism (volumetric) - Salinity	Tidal prism will increase, resulting in enhanced tidal elevations, increased water velocity/flushing, and reestablishment of a salinity gradient throughout the inlet. Size of restored tidal prism is directly dependent on degree of stressor removal.	Immediately following restoration.	Considerations: - Calculation of full, restored tidal prism and associated size of inlet opening Potential actions: - Increase size of inlet opening - Topographic restoration
Secondary Indicators					
Inlet opening maintenance and migration	Tidal hydrology Freshwater input Tidal	- Cross-section and bathymetry of inlet opening	Inlet will maintain an opening sufficient for restored tidal prism. Restored flow through tidal channels will export impounded sediments and import	Immediately following restoration.	Considerations: - Assumption: Inlet will naturally resize to accommodate tidal prism

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
	channel formation and maintenance		water. Erosion and migration of inlet opening are also possible, but not indicators of restoration success.		- Impounded sediments inside the inlet - Sediment source outside the inlet - Water velocity/flushing sufficient to maintain opening Potential actions: - (Further) removal of fill/impounded sediments
Tidal channel network development	Tidal hydrology Freshwater input Tidal channel formation and	- Dendritic tidal channel geometry measurements - Channel density - Channel cross-sections - Panne and pond	More distinct, larger tidal channels will form. Where a single starter channel has been excavated, a more complex network will develop.	Rate of tidal channel network development depends on size of restored tidal prism.	Considerations: - Assumption: excavation of higher order channels will allow lower order channels to develop naturally

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
	maintenance	size distribution relative to channel network - Site-scale topography/bathymetry - Local erosion and accretion	Enhanced flow through channels will change sediment deposition patterns, resulting in erosion within the channels and deposition in backwater areas.		Potential actions: - (Further) channel excavation - Promote meanders with engineered log jams
Estuarine delta formation, including dendritic marsh channel network development	Tidal hydrology Freshwater input Tidal channel formation and maintenance	- Marsh area and edge density - Channel configuration - Sediment composition and structure	Network of dendritic intertidal marsh and marsh drainage channels will develop, increasing marsh area and complexity. Delta structure will change, including a reduction in delta "cones." Increased water velocity through the channels will result in coarser sediment overall.	Rate of tidal channel network development depends on size of restored tidal prism.	Considerations: - Have management actions interfered with existing drainage pattern? - Assumption: excavation of higher order channels will allow lower order channels to develop naturally Potential actions: - Filling of existing

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					drainage channels - (Further) channel excavation - Promote meanders with engineered log jams
Enhanced water quality	Tidal hydrology Freshwater input Tidal channel formation and maintenance Detritus recruitment and retention	- Dissolved organic carbon - Dissolved oxygen - pH - Temperature - Turbidity - Chlorophyll a - Sediment oxygen demand	Increased flushing and connectivity will lead to enhanced water quality in terms of habitat conditions (i.e, indicators directly relevant to biology), including decreased temperature.	Rapid improve-ment expected after restoration of tidal hydrology and freshwater input.	Considerations: - Water velocity and other indicators of flushing - Channel drainage network development Potential actions: - Active management such as baffles, aerators, etc. - Applied studies to find causes of water

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					quality problems
Large woody debris (LWD) accumulation	Detritus recruitment and retention	- Large wood composition, recruitment, and residence	Woody debris will be carried in naturally from restored tidal and freshwater flushing. Debris will contribute to the amount of organic carbon in the system, but should not interfere dramatically with flushing.	Potential for accumulation immediately following restoration of tidal hydrology; actual rate depends on flow rates.	Considerations: - Is inlet opening/freshwater connection large enough to allow passage of LWD? - Source of LWD Potential actions: - Increase size of inlet opening/freshwater connection - Removal and relocation of LWD from locations that cause blockage to flow, particularly following weather and/or inundation events

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
Colonization of native vegetation	Tidal channel formation and maintenance Detritus recruitment and retention	- Distribution and abundance of native plants by type - Species richness - Distribution and abundance of invasive plants	Vegetation assemblage will develop and change based on restored salinity and topography regime. In particular, assemblage should change from freshwater to saltwater marsh upon reconnection to tidal flushing.	Expected to occur rapidly upon restoration of tidal hydrology	Considerations: - Disruption by management measures, (e.g., removal of fill) - Potential barriers to organism exchange - Marsh plain elevation and topography - Water quality metrics - Invasive plant colonization Potential actions: - Revegetation, particularly following fill removal - Regrading of

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Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
					marsh surface - Invasive plant removal

Tertiary Indicators

Increased habitat area, quality, and complexity	ALL	- Distribution and extent by habitat type - Intertidal and shallow subtidal area - Shoreline length and complexity - Habitat quality rating based on sediment, water, vegetation measurements collected as part of this monitoring plan. - Landscape connectivity and	A greater diversity and functionality of habitats will develop. In particular, habitats with conditions (sediment size, water quality, vegetation) appropriate for shellfish, salmonid rearing spawning, and feeding will increase in area. Development of complex channel networks will result in enhanced shoreline length and complexity. The site should develop redundant representation of the full range of coastal inlet	Extent and quality of habitats will respond gradually following establishment of all structural responses.	Considerations: - Analyze all available monitoring data to determine whether result is due to restoration or external factors Potential actions: - Assess relative to all other monitoring metrics – if processes have been restored but habitat function has not, consider change to

Structural/Functional Response	Restored Process(es)	Monitoring Metrics	Predicted Response	Predicted Timeframe	Adaptive Management Response
		patchiness	components including creek delta with swamp, salt marsh, tide flat, and channels where historically present. The site should be formed of contiguous large patches that are well connected to each other and to the adjacent river, terrestrial, and marine landscapes.		conceptual model

5. Implementation of Effectiveness Monitoring

Effectiveness monitoring, using the framework outlined in Section 4, will be initiated upon completion of construction of the restoration site, although studies may have occurred at one or more reference sites prior to this time. According to Corps guidance, monitoring will be cost-shared between the Corps and the non-Federal sponsor for 10 years, after which time all costs will be the responsibility of the non-Federal sponsor. Once achievement of project objectives has been demonstrated by monitoring results and documented by the Corps and the non-Federal sponsor, no further monitoring will be required (USACE 2009). However, the non-Federal sponsors and other organizations pursuing more in-depth resolution of scientific uncertainties addressed by the site may continue certain elements of the effectiveness monitoring as part of more comprehensive validation monitoring efforts.

5.1 Development of Site-level Monitoring Plans

Earlier sections of this document provide a framework for monitoring PSNERP restoration strategies, and should be used to develop specific monitoring plans for individual sites. Site sponsors should draw from current scientific understanding, reference sites, historical conditions, stakeholder input, and traditional ecological knowledge to develop plans that satisfy the unique monitoring needs of each site. The Conceptual Design Report for each of the sites should be reviewed to determine if the identified site-specific risks and uncertainties have associated monitoring needs.

As required, additional scientific investigations and modeling should be used to develop site-specific predicted ecological outcomes and select appropriate metrics to measure and track these outcomes. Site-specific plans should also address monitoring of potential construction-related impacts such as sediment suspension or contamination from nearshore fill removal. To ensure integrity of the monitoring plan, site sponsors should work with PSNERP scientists, local scientists, and local resource managers to define monitoring targets for each metric, as well as an estimate of how long the site will need to be monitored before declaring functional performance.

5.2 Site Monitoring Design

5.2.1 Sampling Methodology

Design and implementation of site-specific monitoring of a restoration action should ideally originate with the development of restoration goals framed in part by the ecosystem processes, structure, and functions targeted for restoration. Effective monitoring of progress toward these goals can then be achieved through a scientific framework of repeated sampling, long-term data sets, and statistical analysis. Standard, proven, and repeatable monitoring methods should be used where possible to make results comparable across all PSNERP restoration sites. Monitoring methods should incorporate flexibility and event-triggered sampling to account for schedule interruptions due to natural variability, stochastic events, and regional trends. In general, sampling approaches and

instrumentation selected for each restoration site should prioritize standardization and cost-effectiveness. For example, photogrammetric remote-sensing could be employed to provide information on a large number of monitoring metrics across all four restoration strategies.

Change can occur over multiple temporal and spatial scales, and this heterogeneity should be reflected in monitoring design. The landscape-forming processes that are the focus of PSNERP restoration strategy vary within a given region, and may encompass multiple ecosystem units. These processes typically range from meters to hundreds of meters (e.g., cross-beach, tidal slough) or hundreds of meters to kilometers (e.g., along-beach within a drift cell, or within a salinity regime). Site-scale monitoring is intended to examine development of these processes within the footprint of the site; this monitoring should include analysis of the restoration site as well as any reference sites. In general, monitoring should demonstrate trends through time, and sampling frequency should differ for each monitoring metric according to temporal scale, monitoring questions, resource availability, and instrumentation capacity. However, change that occurs early after restoration is often accelerated. As such, intensive monitoring that allows for contingency planning should occur in the first five to 10 years after restoration, followed by a period of less frequent sampling.

5.2.2 Reference Sites

Linking a desired ecosystem response to a specific management measure within a site will require careful selection of the most appropriate reference site(s), which should be explicitly identified as part of the site-specific monitoring plan. A reference site provides a basis of comparison to the restoration site and to pre-restoration conditions, helps inform acceptable values for monitoring metrics (Goetz et al. 2004), and can serve as a covariate that takes into account natural variability (Roni et al. 2005). It should have a minimal history of anthropogenic disturbance and exhibit a natural range of processes, and thus the target condition for the restoration (NRC 1992). The reference site should be comparable in process, structure, and function to the restoration site before it was degraded. Despite the challenges of identifying a relatively undisturbed reference site that is directly comparable to the restoration site, monitoring often involves pairing of treatment and reference (or "control") sites in a BACI (Before-After-Control-Impact) methodology to distinguish natural from treatment variability, and to reduce sample size and simplify data analyses (Roni at al. 2005). In general, the reference and restoration sites should be monitored with similar intensity to allow for more direct comparison of monitoring metrics, and baseline data should be collected from both reference and restoration sites before construction in order to detect change in critical processes over time.

The considerable natural variability in natural ecosystem processes (e.g., those influenced by landscape setting) often calls for monitoring a suite of reference sites (Short et al. 2000; Anisfeld 2012). The optimal timing for incorporation of reference sites, and particularly a complex of reference conditions, would be in the planning stage of the restoration, when goals are defined. However, inclusion of reference site structure and processes, much less ecosystem function, is inconsistent and relatively rare among the restoration sites

considered by PSNERP. Comprehensive development of a suite of reference sites to monitor in concert with the PSNERP restoration sites would likely fall under broader, programmatic coordination with the non-Federal sponsors, especially when validation monitoring (see Section 6) is incorporated into such a comprehensive monitoring scheme. Such a coordinated approach would potentially serve other Federal and non-Federal restoration actions, as well as draw on established nearshore ecosystem monitoring, such as the Padilla Bay National Estuarine Research Reserve's long-term monitoring and research, to serve the needs of the broader Puget Sound restoration community.

5.3 Organizational Framework

Due to the complex nature of management of lands and natural resources, monitoring must be an inter-institutional effort. While it is possible that a centralized organizational framework may be established to oversee monitoring and analyze results, each of the 19 PSNERP restoration sites will not necessarily be monitored by the same organization. Instead, as part of the development of the site-specific monitoring plan, entities other than the Corps or the non-Federal sponsor will perform the monitoring at some or all restoration sites. Entities responsible for monitoring will provide monitoring results back to the Corps and the non-Federal sponsor. This direct line of communication is critical to allow for active contingency planning. All parties who are involved in or affected by the restoration site must have access to monitoring results, and results should be publicly available. The Corps will use these results in consultation with the non-Federal sponsor to guide decisions regarding any necessary mid-course corrections to the management measures applied at a restoration site (USACE 2009). They will also be used by PSNERP to continue to develop and improve new restoration actions that move the program toward its overall objectives.

Because ecosystem restoration affects people both within and outside of the program at every stage, stakeholder involvement and public outreach should be as transparent and inclusive a process as possible. Broad stakeholder involvement will benefit restoration planning by ensuring use of the best possible scientific information, including local and traditional ecological knowledge. Individual stakeholder groups may complement the program's assessment of monitoring results with analyses that cater to a specific ecosystem service, such as forage fish spawning or juvenile salmon rearing habitat.

In order to maximize the benefits of PSNERP restoration sites, monitoring efforts must be integrated with other outreach efforts of the broader Puget Sound restoration community. In general, stakeholder input at every level is necessary to address complex restoration issues, such as competing land uses or risks to adjacent properties, successfully. This can be accomplished through a combined strategy of sponsored community workshops, ongoing informal dialogues, and leveraging the outreach capabilities of involved, local non-governmental organizations. By fostering a relationship with the public, the Corps can facilitate the success of PSNERP restoration actions, and assist with broader nearshore ecosystem restoration in Puget Sound. Such information feedback will lead to better understanding of nearshore ecosystem restoration that will increase functional performance of PSNERP actions. Sharing of both emerging monitoring results as well as

adaptive management actions will facilitate learning and programmatic improvement: restoration actions and scientific investigations conducted concurrently outside of PSNERP may provide insight into new science needs, restoration strategies, and monitoring approaches. Communication and collaboration should be fostered and maintained with Federal, state, and local agencies, as well as tribal governments, non-profit organizations, and community groups. This can be done as a continuation of the Stakeholder Involvement Plan developed during the feasibility phase of the GI. In addition to information sharing, this collaboration may include cooperative planning efforts, shared construction, shared operations and maintenance, or shared monitoring activities.

5.4 Analysis and Reporting

In order to support management of restoration sites, raw monitoring data and basic field reports should be supplied to the party conducting data analysis as soon as possible following data collection. Raw monitoring data must be processed and converted into actionable information. This involves quality control, statistical analysis, and summary and presentation in regular reports. These reports should emphasize full reporting and synthesis of results into coherent narrative and graphical presentations. They should be provided in a timely manner to the Corps and non-Federal sponsor, and published online through the PSNERP website for consumption by the broader restoration community and the public.

When appropriate, PSNERP should seek peer-review of the synthesized monitoring results. In general, peer review is a critical element of any science-based program. It helps to ensure use of best available science, can validate or provide alternative interpretations of monitoring results, and can make methods and conclusions defensible. PSNERP has incorporated product-specific peer review of technical documents as well as programmatic review of science usage into the selection process for restoration sites. Under this monitoring framework, peer-review will continue for reports, decision-support tools, and other products generated from monitoring results. Results should also be shared less formally through participation in regional conferences and major science symposia such as the Salish Sea Ecosystem Conference. These events can serve as two-way conduits for restoration knowledge between PSNERP and the broader restoration community. Ultimately, PSNERP should ensure that results from monitoring and adaptive actions are integrated with broader regional management initiatives, such as the Puget Sound Partnership's Puget Sound Science Update.

5.5 Data Management

In order to inform restoration science and decision-making into the future, monitoring data must be preserved and stewarded for long-term access and usability. Formal archiving is critical to ensure establishment of institutional memory within the program, and to develop the redundancy and long time series necessary for rigorous statistical analysis. A data management plan separate from this document should be developed in the pre-construction phase before monitoring data begin to flow. This plan should identify an agency or organization capable of providing long-term stewardship of the data while adaptively meeting the needs of the Project. Ideally, this agency will provide the full suite of

archival services, including ingest, data management, archival storage, access, preservation planning, and administration (CCSDS 2003).

The data management plan should provide for data discovery and access by the public. This may be accomplished directly by the archival agency, or through a separate online portal. Data should be made available in standard, well-documented formats, so that they can be incorporated into a larger Puget Sound-wide data set. This will enable timely use of the data for site-scale improvement and adaptive management responses within the program. It will also allow scientists inside and outside of PSNERP to inform and refine ecosystem models, which in turn can be used to predict outcomes for future restoration actions or programs.

6. Validation Monitoring

Whenever feasible, effectiveness monitoring of PSNERP restoration sites should be integrated with regional initiatives that are testing the assumed linkages between functional objectives and overall goals of Puget Sound-wide conservation and restoration programs. Linking to these external monitoring and science efforts would increase understanding of the relationship between PSNERP's process-based restoration and the delivery of ecosystem functions, goods, and services (EFG&S). Validation monitoring is secondary to this document, and is not a responsibility of the Corps and non-Federal sponsor. Thus, the PSNERP strategy for validation monitoring involves enabling monitoring efforts of relevant EFG&S by other groups in Puget Sound. This strategy enhances PSNERP's connection to the broader Puget Sound restoration community, while simultaneously collecting valuable validation monitoring information that can be used to improve the next generation of restoration sites in Puget Sound.

6.1 Goals

Alterations of natural processes damage nearshore ecosystem structures and functions, all three of which provide EFG&S that people value. There is an emerging policy focus on framing restoration benefits in terms of EFG&S, which would allow more direct economic valuation. However, the response of EFG&S to specific restoration actions is difficult to predict due to a high degree of influence from external factors, natural variability, and uncertainty in response timing. For this reason, validation monitoring is not used to evaluate the effectiveness of restoration actions. Instead, the goal of validation monitoring is to increase understanding of the relationship between process-based restoration actions and EFG&S. This includes increasing predictability of social attitudes about nearshore ecosystems and the social and economic benefits derived from their restoration.

6.2 Approach

Validation monitoring of PSNERP restoration should be framed around the assumed linkages between process-based restoration and EFG&S. Where feasible, EFG&S can be monitored directly and results compared to predicted functional outcomes. These predictions are based on historical provision of EFG&S by a given system, as well as current scientific understanding of that system. Although EFG&S encompass a broad suite of provisioning, regulating, supporting and cultural benefits to humans (Simenstad et al. 2011), PSNERP has attached particular emphasis to Valued Ecosystem Components (VECs; Leschine and Peterson 2007). Although VECs form a very small subset of the EFG&S provided by Puget Sound nearshore ecosystems, they are intended to represent ecologically and socially relevant beneficiaries of PSNERP restoration actions, and are recognized by many people as emblematic of a "healthy" Puget Sound (Schlenger et al. 2011). Due to their regional importance, many efforts are underway across Puget Sound to monitor many of the VECs, providing PSNERP with opportunities to link their restoration actions to validation-monitoring goals.

The PSNERP restoration sites will provide opportunities to learn how various aspects of nearshore ecosystem restoration influence and are influenced by public perception and

attitudes. Social data collection is especially important to those restoration sites constrained by private property. Willingness-to-pay or other valuation indicators can be used to assess how much the public values non-commodity EFG&S such as aesthetics. Social and economic monitoring are beyond the scope of the monitoring tasks performed by the Corps and non-Federal sponsor, but their analysis can be facilitated through efforts monitoring VECs. As more detailed plans for PSNERP implementation monitoring are developed, opportunities to leverage this investment and coordinate with Sound-wide monitoring efforts to address validation monitoring will be pursued.

6.3 Predicted Functional Outcomes

Although Puget Sound's nearshore ecosystems provide many EFG&S, one of the more important EFG&S is the provision habitat for a variety of fish, shellfish, birds, and other wildlife. Many species and life history types of juvenile Pacific salmon rely on tidal marshes and channel networks of deltas and small estuaries and shorelines of the barrier beaches of open coastal inlets for rearing and foraging. In addition, over 30 species of shorebirds, as well as migratory and predatory birds, use these habitats for migration, forage, feeding, roosting, and reproduction (Collins and Sheik 2005; Buchanan 2006; Dethier 2006; Fresh 2006; Eissinger 2007; Mumford 2007; Penttila 2007). In addition to these valued habitat functions, nearshore ecosystems provide EFG&S that are economically important, including production of benthic invertebrates and insects, nutrient cycling, water filtration, drainage and flood management, recreation, and shellfish production (Schlenger et al. 2011).

6.4 Uncertainties and Programmatic Improvement

Validation monitoring addresses uncertainties associated with the assumptions linking PSNERP process-based restoration with the delivery of EFG&S. These include questions regarding the impacts of stressors to nearshore processes on EFG&S, such as whether such impacts can be effectively reversed by site-specific restoration. Compared to structural and functional responses, predicted ecological outcomes are often less clearly or directly linked to restoration actions for EFG&S. As a result, causal relationships are difficult to define from monitoring results at the site scale. Analysis of validation monitoring results from a collection of restoration sites within a single strategy group, or across many regional restoration and protection initiatives, reduces these uncertainties.

As might be expected from the embryonic science and technology of ecosystem restoration, there are a plethora of uncertainties associated with assumptions about EFG&S that will reliably derive from the many management measures deployed, as well as across different types and scales of Puget Sound's nearshore landforms. An extensive list of questions was compiled for the comprehensive PSNERP research plan (Gelfenbaum et al. 2006), many of which are still unresolved and would be critical candidates for focused validation monitoring that could be deployed among the program's candidate restoration sites. A few examples of some of the more persistent uncertainties that still plague restoration planning and design across individual- to multiple-site scales, and which are prime candidates for validation monitoring, include:

Management measure-specific:

- Restoring Tidal Hydrology
    - Will dendritic tidal channel systems evolve more naturally complex plan-form structure (in erosive sediments) without intervention than with constructed tidal channels?
    - Is there a difference between dike breaching and dike removal in vegetation recruitment and fish utilization of a recovering wetland?
- Bulkhead Removal
    - What are the attributes of forage fish habitat that are restored or enhanced by a bulkhead removal?
    - At what scale does bulkhead removal become meaningful/beneficial? How effective are alternative techniques and do they restore the relationships among processes, structure, or functions?
- Beach Nourishment
    - Will forage fish spawn on nourished beaches?
    - Does sediment placed on the beach face move offshore to benefit nearshore biota outside the nourishment footprint?
    - Independent of a management measure or comprising multiple measures:
    - How does variability in site-scale habitat features (e.g., water depth and vegetation characteristics) and landscape-scale habitat features affect juvenile salmon and other VEC performance?
    - Is there a cumulative effect of restoring degraded nearshore ecosystems that are adjacent to protected/conserved shorelines?

For the same reason EFG&S responses are difficult to predict, they are also difficult to address through site-scale contingency planning. Results from validation monitoring of EFG&S are therefore used primarily for programmatic improvement, e.g., "adaptive learning" (McLain and Lee 1996). Analysis of these results can be used to increase scientific understanding of the links between restoration actions and EFG&S for a given strategy, which could lead to a shift in scope or approach for the next generation of restoration sites. Ultimately, the benefits of process-based restoration of nearshore ecosystems could be defined in terms of the EFG&S they provide, linking these directly to process, structure, and function and strengthening to our understanding of Puget Sound's nearshore ecosystems.

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PUGET SOUND NEARSHORE
ECOSYSTEM RESTORATION

APPENDIX F

SUPPLEMENTAL INFORMATION ON THE AFFECTED ENVIRONMENT

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps
of Engineers
Seattle District

Puget Sound Nearshore Ecosystem Restoration Study

Appendix F – Supplemental Information on the Affected Environment

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1 Introduction

The information presented in Chapter 3 of the Feasibility Report/Environmental Impact Statement focuses on resources of high ecological, cultural, and/or socio-economic value. This appendix provides further information on these resources that were analyzed during the plan formulation and decision-making process.

2 Rare and Unique Habitats

2.1 Rocky Shorelines

The only land form type that PSNERP objectives do not address is the rocky shoreline. This is largely because the rocky shoreline have remained unchanged from historic conditions due difficulty in modifying bedrock. These rocky shorelines host diverse communities of kelp, invertebrates and fish species. These communities can be affected by the degraded conditions of other adjacent land forms by way of degraded water quality (including temperature, siltation, and turbidity). The highest macro-invertebrate diversity in Puget Sound is found along the rocky shoreline. These diverse communities can be attributed largely to the combination of three-dimensional structure and primary production provided by floating and understory kelp (see table 1 for a summary of kelp species), and the hard substrate provided by bedrock. Many of these invertebrates are anchored to the bottom to avoid being swept away by the swift currents and surge that bring a constant source of nutrients and oxygen to kelp and algae beds. Assemblages and richness of invertebrates in the rocky shoreline tend to increase with length of tidal inundation. The table 2 summarizes invertebrate communities typical of rocky shorelines of Puget Sound, the Strait of Juan de Fuca and the San Juan Islands.

Table 1 Rocky Shoreline Vegetation (Kozloff 1973)

Zone (MLLW)	Vegetation
Zone 1 (+9 to +7)	Lichens, seaside plantain, thrift, and the occasional green alga
Zone 2 (+7 to +4)	Black lichens, rockweed (*Fucus* sp.), soda straws (*Scytosiphon* sp.), a variety of red algae, sea lettuce (*Ulva* sp.), sea tuft (*Cladophora).*
Zone 3 (+4 to 0)	Sea lettuce and rockweed, sea cauliflower (*Leathesia* sp.), sea sac (*Halosaccion* sp.), and sea lace (*Microcladia*).
Zone 4 (0 to -3.5)	Giant kelp (*Macrocystis*) along the Strait of Juan de Fuca, sugar kelp (*Laminaria),* shotgun kelp (*Agarum* sp.), feather boa kelp (*Egregia* sp.), winged kelp (*Alaria* sp.), common bull kelp (*Nereocystis*), coralline algae, Turkish towel (*Chondracanthus* sp.), sea brush (*Odonthalia* sp.), purple laver (*Porphyra* sp.), and veined blade (*Hymenena* sp.).
Zone 5 (-3.5 to extent of photic zone)	Similar to zone 4

Table 2 Rocky Shoreline Invertebrates (Kozloff 1973, 1993)

Zone (MLLW)	Invertebrates
Zone 1 (+9 to +7)	Small herbivorous and carnivorous mollusks such as periwinkles, dogwinkles, whelks, and limpets, and crustaceans such as barnacles, isopods, and hermit crabs
Zone 2 (+7 to +4)	Similar to zone 1
Zone 3 (+4 to 0)	California mussel (*Mytilus californianus*) and goose barnacle (*Pollicipes polymerus*) where there is significant wave action, edible mussels (*Mytilus edulis*) in protected areas, chitons, whelks, and other snail and slug like organisms (*Granulina* and *Onchidella* sp), purple and green shore crabs, hermit crabs, porcelain crabs, black clawed crabs and ochre sea stars (*Pisaster ochraceus*) found in purple and orange morphs
Zone 4 (0 to -3.5)	-Giant nudibranch, sea lemons, dorids, dorinas, and shag mouse sea slugs -Chitons, northern abalone, scallops, whelks, and tritons -Giant pacific octopus, red octopus - Sea cucumbers, sunflower stars, bat star, ochre stars, brittle stars, red and green sea urchins - Plumose anemones, green anemones, strawberry anemones, various pelagic jelly fish, ascidians, sea squirts -barnacles, crabs (such as hermit, decorator and kelp crabs), isopods, and shrimp
Zone 5 (-3.5 to extent of light)	Similar to zone 5

Fishes found along the rocky shoreline include larger benthic species such as lingcod, kelp greenlings, cabezon, Irish lords, buffalo sculpin, many species of rock fish, and numerous smaller fish including sail fin and tidepool sculpin, clingfish, blennys, pricklebacks, and gunnels. Bird use of rocky shorelines varies among species, as well as the time of year. Some birds, such as the black oyster catcher, are year-round residents where they feed on mussels, limpets, barnacles, and other mollusks and crustaceans that are unique to rocky shorelines. Other birds typical of rocky shorelines include harlequin ducks, turnstones, surfbirds, pigeon guillemots, auklets, and belted kingfishers.

2.2 Rare Plant Communities

The coastline of Puget Sound is host to a variety of plant communities. Some of these communities have become sparse due to human-related factors, while others are naturally rare on the landscape. The Washington Natural Heritage Program has compiled a list of plant associations in Washington State that are considered rare. In addition, they have identified ecological communities that are "rare" based on vulnerability and percent decline. The following sections describe the Puget Sound shoreline's ecological communities that are considered highly vulnerable with very large, large, or substantial decline, along with communities that have not necessarily been identified as vulnerable, but contain rare plant

associations (Crawford, WA Natural Heritage Program, pers. comm.; Natural Heritage Program 2008).

2.2.1 Coastal Prairies

Coastal prairies are among the most imperiled plant communities of western Washington and reflect a biological heritage unique to this region. The Washington Natural Heritage Program identifies prairie and savannah as highly vulnerable with a decline of greater than 90 percent. Historically, coastal and lowland prairies spread for hundreds to thousands of acres throughout western Washington; coastal prairies lie on high bluffs of Whidbey and the San Juan Islands and parts of Clallam, Whatcom, and Skagit Counties. Less than one percent remains of about 8,000 acres of prairie originally present on Whidbey Island (Whidbey-Camano Land Trust 2008). Once maintained by Native American burning practices (Chappell 2006a), these grasslands supported a wide variety of species of plants and animals, many found nowhere else. Prairie soils are typically shallow and very dry, often with southern or western exposure. Dominant plants in these environments included grasses (*Festuca rubra* and *F. idahoensis v. roemeri* most consistently present) and small herbaceous (e.g., *Grindelia integrifolia* and *Cerastium arvense*) and bulbous perennials (*Camassia leichtlinii*). Golden paintbrush (*Castilleja levisecta*) symbolizes these coastal grasslands, but has become threatened federally and critically imperiled globally. The Washington Natural Heritage Program identifies two Puget Sound shoreline prairie communities as rare: red-fescue-great camas-Oregon gumweed (shoreline grasslands) and Roemer's fescue-field chickweed-prairie junegrass (coastal bluffs and balds). Only nine occurrences of good quality fescue-gumweed-great camas communities remain in Puget Sound (Chappell 2006a). While historically coastal prairie distribution was limited historically by natural conditions (soil type, hydrology, ect.), factors such as development, recreation, invasive species, and the fire suppression that leads to native lowland forest colonization have left few remaining occurrences of these ecological communities.

2.2.2 Pacific Madrone

Three Pacific madrone-dominated associations, described as critically imperiled or imperiled in the state of Washington (Chappell 2006b) are found in a similar landscape as coastal prairies. Sites are often very dry, with shallow soils of relatively low nutrient status and sunny aspects adjacent to saltwater. Fewer than 30 occurrences are known throughout the Puget Sound region. Often co-dominated with Douglas fir (*Pseudotsuga menziesii*), madrone (*Arbutus menziesii*) forms a sub-canopy below the taller fir. Composition of the understory varies by location and association but may include salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), ocean spray (*Holodiscus discolor*), and snowberry (*Symphoricarpos albus*). The Washington Natural Heritage Program identifies the following madrone associations as rare: Douglas fir-Pacific madrone-hairy honeysuckle and Douglas fir-Pacific madrone-salal. While it is likely that these were naturally rare associations, poor timber practices, fire

suppression, and fungal diseases are all potential threats. Madrone responds positively to high-intensity fire and will re-sprout after logging; Douglas fir subordinance or even absence is a consequence of fire, clear-cutting, or selective Douglas fir logging. Douglas fir appears to increase in abundance without disturbance but is not thought to out-compete madrone. Non-native fungal diseases are likely implicated in the overall decline of madrone-dominated associations. Madrones provide an important source of fall and winter fruit forage for birds.

2.2.3 Tidal Freshwater Wetlands

Freshwater tidal or surge plain wetlands were once common throughout the Puget Sound nearshore zone. Unique to the freshwater extent of river deltas, the water levels rise and fall with the tides but the water is fresh (less than 0.5 parts per trillion salt). Generally these are high-nutrient and high-energy systems (Kunze 1994). Some historical logging data on stream-side and tidally influenced stream-side trees indicate spruce (*Picea sitchensis*) dominated plant communities. Spruce is not considered a dominant tree species in this region (Brennan 2007). Vegetation communities are varied and depend on substrate and flood regime characteristics. In the very rare undeveloped locations, forested swamps of spruce, alder (*Alnus rubra*), or occasionally pine (*Pinus contorta contorta*) may be found in upstream tidal areas (Boule 1981). Associated understory species could include dogwood (*Cornus sericea*), hardhack (*Spiraea douglassi*), and salmonberry (*Rubus spectabilis*). The analysis of changes in distributions of wetlands between the late 1800s and circa 2000 indicates that less than 10 percent of the historical area of tidal freshwater wetlands remains in Puget Sound (Simenstad et al. 2009). The Washington Natural Heritage Program identifies freshwater tidal wetlands as highly vulnerable with a substantial decline. Loss of freshwater tidal wetlands can be attributed to sea dikes and levees, filling of estuaries for agriculture production, and commercial and residential development.

2.2.4 Spit Berms

Backshore spit/berm habitats are found on sand spits that are not regularly inundated but receive some salt influence from spray or high tides. The substrate is usually a mix of sand and gravel, and drift logs are often present. Dominant plants include dunegrass (*Elymus mollis*), gumweed (*Grindelia integrifolia*), and yarrow (*Achillea millefolium*) (Ritter et al. 1996). The Washington Natural Heritage Program identifies the following spit berm plant associations as rare: American dunegrass-beach pea and red fescue-silver burr ragweed. The effect of the waves and wind creates a relatively unstable substrate.

3 Other Nearshore Species

The species described below where not described in Chapter 2, but warrant some discussion due to their reliance on the nearshore zone and/or their cultural and recreational significance in the region.

3.1 Anadromous Fish

3.1.1 Sturgeon

White sturgeon are long-lived broadcast spawners that spawn in high flow areas of large rivers. The young are found only in freshwater, while adults move freely between freshwater, estuary, and marine environments. It is rare to find white sturgeon in southern Puget Sound or Hood Canal; they are, however, seasonally common especially in shallow nearshore waters of the northern river deltas, namely the Skagit, Stillaguamish, and Snohomish Rivers. Those that are present in Puget Sound are migrants searching for food, and likely to have hatched in the Columbia or Fraser Rivers (Pacific States Marine Fisheries Commission 1996).

Green sturgeon may enter Puget Sound to forage in the nearshore zones of bays and estuaries; however, no spawning occur in Puget Sound rivers (see Rare, Threatened, and Endangered Species for more detailed information on green sturgeon).

3.1.2 Lamprey

Pacific and river lamprey are found in rivers and streams of Puget Sound and Hood Canal. Like other anadromous fish, lampreys migrate from marine to freshwater to spawn. The larvae, or juveniles, live in silt and mud substrate until they metamorphose. The young adults then migrate to saltwater where they will begin actively feeding. Adult lamprey are usually found at depths deeper than the nearshore zone; however, they do transit the nearshore during their migration to and from freshwater (Wydoski and Whitney 2003).

3.1.3 Forage Fish

There are two anadromous species of forage fish in Puget Sound: longfin smelt and eulachon. They spend a portion of their life in marine waters, but spawn in the substrate of rivers. Only longfin smelt spawn throughout Puget Sound rivers and streams, including the Nooksack, Duwamish, and Cedar Rivers. The Lake Washington population is landlocked, with individuals of this species spending their entire lives in freshwater (Fresh 2006). Longfin smelt are thought to have the most geographically restricted spawning habitat of all anadromous fish in Puget Sound (Wydoski and Whitney 2003). When longfin smelt are in marine waters, they generally inhabit the deeper pelagic zone, so they are not consistent tenants of the nearshore zone. The only documented eulachon spawning near Puget Sound is in the Fraser River in southern British Columbia (Wydoski and Whitney 2003). More details on eulachon are discussed under the Rare, Threatened, and Endangered Species sections.

3.2 Marine Fish

3.2.1 Rockfish

Rockfish are part of the family Scorpaenidae, and also belong to an informal group referred to as "bottomfish" along with species such as pacific cod, lingcod, and flatfish. There are more than 27 species of rockfish recorded within Puget Sound, with additional species found in the Strait of Juan de Fuca (PSP, 2008). Many of these species occupy shallow waters during some portion of their life history. Rockfish are typically associated with areas of various amounts of hard, complex substrate (reef habitat); making them an attraction for scuba divers in the region. They are common in the kelp covered rocky shorelines of the San Juan Islands and the Strait of Juan de Fuca and are also present in Puget Sound proper in and around boulder-cobble substrate and artificial reef structures such as sunken boats. Kelp and eelgrass beds function as valuable nursery habitat for the juveniles of many rockfish species. Fertilization is internal in rockfish and embryos develop within the female until they are released as pelagic larvae. These larvae drift for three to six months at varying depths (depending on the species) before settling on the benthos. Once settled they have a high fidelity to the site, rarely moving far from their home range. Many species of rockfish are long-lived (yelloweye have been aged at 100+ years old) and late maturing; only successfully producing offspring every decade or so (Love et. al, 2002). These life history strategies have made some species extremely vulnerable to fishing pressures, ultimately leading to the listing of three species in Puget Sound under the Federal Endangered Species Act (ESA).

4 Additional Information on Significant Species

The information presented in Chapter 2 on forage fish, salmon, and ESA listed species focuses on their use of the nearshore zone. Below is further discussion on their status in Puget Sound.

4.1 Forage Fish

Although forage fish in Puget Sound are not considered in peril, the stock status of two species, Pacific sand lance and surf smelt, is not tracked and largely unknown. Pacific herring are the only forage fish stock in Washington State monitored by WDFW. The cumulative abundance of south and central Puget Sound herring stocks in recent years is comparable to that observed in the 1970s and 1980s, while the Cherry Point stock, and north Puget Sound (excluding the Cherry Point stock) and Strait of Juan de Fuca regional spawning biomasses are at low levels of abundance. WDFW classifies forage fish spawning grounds as "marine habitat of special concern" and has a no net loss policy. Herring and surfsmelt are harvested commercially, but harvest of sandlance has been banned due to the importance of their role in the food web (Penttila 2007).

4.2 Salmon

Over the past few decades, salmon runs have severely declined for reasons including hydropower and water diversion, hatcheries, loss of estuarine and freshwater habitat, chemical contamination, fishing pressure, and ocean conditions warranting protection of certain Evolutionary Significant Units (ESUs) and Distinct Populations Segments (DPSs) under State and Federal Endangered Species Acts (see following section for more information on ESA listed salmonids). WDFW monitors the status of all runs of salmon and steelhead in Washington State and characterizes them as healthy, depressed, critical, or unknown. Critical stocks are defined as those that have declined to the point that the stocks are in danger of significant loss of genetic diversity, or are at risk of extinction. Depressed stocks are defined as those whose production is below expected levels, based on available habitat and natural variation in survival rates, but above where permanent damage is likely. The results are released every 10 years in Salmonid and Steelhead Stock Inventory reports. Table 3, below, contains a list of all Pacific salmon and steelhead runs in the Puget Sound Area and Strait of Juan de Fuca as of 2002 (WDFW and WWTIT 2002). In 2002, 22% of the stocks were depressed, 4% were critical, and 42% were of unknown status.

Table 3 Salmon Stocks in Puget Sound, by sub-basin (WDFW and WWTIT 2002)

SUB-BASIN	SPECIES	TOTAL NUMBER OF STOCKS	NUMBER OF DEPRESSED STOCKS	NUMBER OF CRITICAL STOCKS
San Juan Georgia Strait	Chinook	2	0	2
	Chum	3	0	0
	Coho	4	0	0
	Pink	1	0	0
	Steelhead	6	0	0
Whidbey	Chinook	8	7	0
	Steelhead	16	6	0
	Coho	7	0	0
	Sockeye	1	0	0
	Chum	5	0	0
	Pink	3	0	0
South Central	Chinook	7	1	1
	Coho	6	2	0
	Sockeye	3	2	0
	Steelhead	7	4	1
	Pink	1	1	0
	Chum	10	0	0
South	Chinook	1	1	0
	Steelhead		1	0
	Coho	3	1	1

SUB-BASIN	SPECIES	TOTAL NUMBER OF STOCKS	NUMBER OF DEPRESSED STOCKS	NUMBER OF CRITICAL STOCKS
	Chum	13	1	0
	Pink	1	0	0
	Steelhead	4	0	0
Hood Canal	Steelhead	11	6	0
	Chinook	2	1	1
	Chum	21	4	1
	Pink	3	2	0
	Coho	8	1	0
Strait of Juan de Fuca	Chum	9	2	1
	Coho	11	2	1
	Chinook	3	2	1
	Pink	3	1	2
	Steelhead	14	2	0
North Central	Coho	2	0	0
	Chum	1	0	0

4.3 Rare, Threatened, and Endangered Species

Information presented in Chapter 2 on Rare, Threatened and Endangered Species focuses on their listing status, use of the nearshore zone of Puget Sound, and factors that have led to their decline. Additional details of their life history, including feeding habits and reproductive strategies, as well as any ongoing recovery efforts in the region appear below.

4.3.1 Northern Abalone

Northern abalone feed on benthic diatoms as juveniles, and on kelp and other macroalgae as adults. Reproduction occurs by way of broadcast spawning, and once fertilized, the larvae drift with the currents for roughly one week until they receive a cue to settle on the substrate. The crustose coralline algae that commonly grow on subtidal rocks (referred to as pink rock) of the San Juan Islands and Strait of Juan de Fuca have been shown to exhibit a chemical cue that induces larval settlement and metamorphosis (Daume et al. 1999).

Joint efforts between WDFW, the University of Washington, and several other private and non-profit groups have experimented with outplanting juvenile northern abalone in the San Juan Islands and the Strait of Juan de Fuca (Save Our Abalone 2009).

4.3.2 Olympia Oysters

Olympia oysters are filter feeders, feeding primarily on phytoplankton. Spawning occurs in the summer when the males release sperm into the water column and females filter it through

their gills, leading to internal fertilization. The larvae are brooded for two weeks and then released into the water column as plankton for 11 to 16 days, feeding on phytoplankton. Larval settlement requires a hard substrate such as shell, wood, or rocks (Dethier 2006).

A variety of agencies, including Puget Sound Restoration Fund and WDFW, are working to restore the Olympia oysters in Puget Sound through reseeding and reef building efforts with oyster shell.

4.3.3 Boccacio, Canary, and Yelloweye Rockfish

Larval bocaccio are pelagic, drifting at the mercy of the currents, usually occupying surface waters. By age 3.5 months, the young will settle and recruit to nearshore habitat. Juveniles are found in much shallower water over rocky substrate with various understory kelps and/or sandy bottoms with eelgrass. Adults generally occupy water 150 to 800 feet deep over rocky outcroppings, boulder fields, and sloping walls and will school with conspecifics and other species of rockfish. Occasionally, these adults will migrate onto mudflats adjacent to rocky substrates. Adult bocaccio were once quite common on steep rocky walls in deeper water of Puget Sound. They can also be found well off the substrata up in the water column. Adults and large juveniles feed on small fish and squid, whereas larvae and small juveniles feed on copepods, krill, diatoms, dinoflagellates, and various larvae (Love et al. 2002).

Larval canary rockfish are pelagic, drifting at the mercy of the currents, and tend to be present in the upper 300 feet of the water column. After 3 to 4 months, the pelagic juveniles settle onto shallow benthic substrates such as tide pools and kelp beds. As juveniles grow, they start to group and move into depths of 50 to 70 feet at the interface between rock and sand during the day and then disperse onto the sand flats at night. The juveniles gradually move from shallower to deeper areas towards the end of summer. Adults occupy depths of 250 to 650 meters in areas with considerable current around pinnacles and high relief rock, often schooling with conspecifics and other species of rockfish. Adults and sub-adults feed on small fish and invertebrates while juveniles feed on copepods, krill eggs, and various larvae (Love et al. 2002).

Very little is known about the larval stage of yelloweye rockfish (year 1), but young juveniles can be found on vertical walls with cloud sponges and anemones at depths greater than 50 feet. Adults and sub-adults occupy rocky nearshore areas with refuge such as crevices, caves, and boulder piles. Occasionally, they will wander onto mudflats adjacent to rocky areas, sometimes in shallower waters. Yelloweye rockfish spend the majority of their time on the substrata where they feed on small fish, shrimp, crab, and lingcod eggs (Love et al. 2002).

There are no Federal recovery efforts for these three species of rockfish. WDFW has a Rockfish Conservation Plan that focuses on managing fisheries, establishing marine conservation areas, reporting and removing fishing gear, and exploring hatchery program and artificial reefs. They also publish recommendations to limit bycatch and mortality from recreational angling (WDFW,

2012). However, this plan and recommendations are for all species of rockfish and do not focus on the specific requirements of ESA listed species.

4.3.4 Eulachon

Eulachon spend most of their lives in the nearshore zone before migrating into the major river systems along the west coast of North America to spawn in the early spring (late February to May). It is believed that eulachon return to the estuary of their birth, but it is not known if they return to the same river from where they hatched. After hatching, larvae are carried downstream and out into the estuary where they feed on zooplankton. As a schooling fish, eulachon travel together in the ocean. They have been found to live near the ocean bottom at depths of 60 to 500 meters (Hay and McCarter 2000) as well as nearshore areas and coastal inlets.

There are no formal recovery plans for eulachon, state or otherwise, although fishing restrictions may partially aid in recovery.

4.3.5 Hood Canal Summer Chum

Chum are anadromous and semelparous (spawn once and die). Chum have evolved to migrate immediately to marine waters upon hatching, limiting their freshwater life history phase. This life history strategy, which chum salmon share with pink salmon (*Oncorhynchus gorbuscha*), reduces the mortality associated with the variable freshwater environment, but makes chum more dependent on estuarine and marine habitats. When the fry first enter saltwater, they assemble in small schools and reside close to shore where they can avoid predators and forage on epibenthic prey. Juvenile chum salmon often use small coastal embayments and eelgrass beds as foraging grounds and refuge from predators. As the young fish grow, they gradually move to deeper water and generally migrate towards open ocean. Some chum salmon juveniles will remain in the nearshore zone until late in their second year before migrating to the open ocean. Mortalities during this early marine life period are primarily the result of predation by birds and other fish species. Adult chum usually return to their natal estuary to spawn (Fresh 2006).

There is no Federal recovery plan for Hood Canal Summer Chum, however WDFW along with Point No Point Treaty Tribes developed a Summer Chum Salmon Conservation Inititive that focuses on elements such as habitat restoration and harvest management (WDFW and Point No Point Treaty Tribes, 2008).

4.3.6 Puget Sound Chinook Salmon

Chinook are anadromous and semelparous (spawn once and die). Within this general life history strategy, Chinook display a wide range of variation including variation in age at seaward migration; variation in length of freshwater, estuarine, and oceanic residence; variation in

ocean distribution and ocean migratory patterns; and variation in age of spawning migrations. Two predominant life history patterns exist in the eastern North Pacific populations: stream-type and ocean-type (Healey 1991). Stream-type populations may rear as juveniles in streams for one to three years prior to migrating out to marine waters, but they most commonly do so as yearlings. Ocean-type populations migrate within their first year, although exact migration timing probably integrates genetic and environmental factors. Among the ocean-type populations of the Skagit River, Beamer and Larson (2004) found a variety of delta-rearing strategies exhibiting a density-dependent relationship and displacement of fry migrants due to lack of habitat capacity.

The primary prey of resident Chinook are forage fish including surf smelt and herring. Adult Chinook return to their natal estuary and migrate upriver to spawn. Reproductive strategies such as fecundity and run timing vary greatly in Chinook salmon and are influenced by a variety of genetic and environmental factors. Chinook viability is tied to the presence of local and landscape-level functioning habitats that can support populations through feeding, migration, and predator avoidance (Fresh 2006).

The Shared Strategy for Puget Sound submitted a plan for Puget Sound salmon recovery organized by local watershed planning areas. The plan has been adopted by NMFS and focuses on habitat restoration, harvest regulations, and interaction with hatchery fish (Shared Strategy Development Committee, 2007). Local responsibility for the plan transferred to the Puget Sound Partnership in 2008.

4.3.7 Puget Sound/ Strait of Georgia Coho Salmon

Coho are anadromous and semelparous (spawn once and die). Coho from British Columbia southward predominantly have a three-year life history cycle. Adults spawn by mid-winter and juveniles either rear in freshwater for up to 15 months before migrating out to the ocean as yearlings, or in some cases migrate immediately to estuarine rearing habitats where they may reside for several months. In British Columbia and Puget Sound, coho exhibit two types of saltwater life history phases: "ocean" types that occupy the outer coastal areas and the "inshore" types that spend their time in the more inland locale. Some coho may exhibit both types and travel to open coastal waters for brief periods and then return to the inland reaches (Groot and Margolis 1997; Goetz, pers. comm., 2009a). Coho are included in the plan for Puget Sound Salmon recovery that has been adopted by NMFS as described above (Shared Strategy Development Committee, 2007).

4.3.8 Coastal/Puget Sound Bull Trout

Bull trout are iteroparous (spawn more than once). They are a wide-ranging species with multiple life history forms and a complex population structure reflecting a high degree of local site fidelity (Kanda and Allendorf 2001) and substantial genetic divergence between breeding

populations (Dunham and Rieman 1999; Spruell and Maxwell 2002). Temperatures above 59 °F are believed to limit bull trout freshwater distribution, which may explain their patchy distribution (Fraley and Shepard 1989; Rieman and McIntyre 1993). Bull trout have migratory and resident life history strategies. Residents spend their entire life cycle in the tributary streams in which they spawn and rear, whereas migratory forms rear in freshwater and then migrate to either a lake (adfluvial), river (fluvial), or saltwater (anadromous) (USFWS 2004). Primary prey items include surf smelt, sand lance, Pacific herring and juvenile salmonids.

According to the USFWS Draft Recovery Plan, bull trout use eight core areas along the eastern side of Puget Sound (Chester Morse Lake, Upper Skagit , Lower Skagit, Nooksack, Puyallup, Snohomish/Skykomish, Stilliguamish, and Chilliwack which is a transboundary river partly in Canada), and six populations on the Olympic Peninsula are limited to the Strait of Juan de Fuca and Hood Canal (Dungeness, Elwha, Hoh, Queets, Quinault, and Skokomish). Each core area has associated populations within it that exhibit varying life history types and spawning areas. Currently, no bull trout populations use tributaries or estuaries on the western side of Puget Sound. However, sub-adults and adults may occasionally migrate across Puget Sound to use the nearshore zone for foraging (Goetz, pers. comm., 2009b). The Federal Draft Recovery Plan for Puget Sound Bull Trout focuses primarily on habitat, including water quality parameters like temperature (USFWS, 2004).

4.3.9 Puget Sound Steelhead

Steelhead are an iteroparous (spawn more than once) species, whereas the Pacific salmon are semelparous (spawn once and die). Anadromous steelhead can spend up to 7 years in freshwater prior to smoltification and then three years in saltwater prior to first spawning. Steelhead usually return to their natal estuary to migrate upstream to spawn, and may spawn up to three times. Steelhead have a complicated life history, and differing combinations of freshwater/saltwater periods lead to many different possible life cycles (Barnhart 1986). All life history stages of steelhead can be present in rivers and estuaries year-round at varying numbers. In Hood Canal, steelhead smolts reside an average of 15 to25 days prior to migrating to the ocean (Moore et al. 2009). Once in saltwater, they quickly move into deeper water, often only spending a couple of weeks in Puget Sound. Their diet while in Puget Sound is largely unknown due to lack of samples, but they are thought to eat squid and small fish (Goetz,pers. comm., 2012). There are no recovery plans for Puget Sound steelhead, Federal or otherwise. However, they would benefit from the recovery efforts for Puget Sound salmon.

4.3.10 Green Sturgeon

This species is a long-lived fish that spends the majority of its time foraging along the coasts and in the large bays and estuaries of California, Oregon, and Washington for benthic dwelling prey such as shrimp, mollusks, amphipods, and small fish. Sturgeon enter freshwater to spawn in the

deep turbulent pools of mainstem rivers where they broadcast their eggs onto clean cobble substrate (Moyle et al. 1995). No spawning habitat occurs in Puget Sound. There are no recovery plans for Green Sturgeon, Federal or otherwise.

4.3.11 Steller Sea Lion

Steller sea lions may be observed along the Washington coast year around, but they are least abundant in May through July, which corresponds to the breeding time off Oregon and British Columbia. Females begin breeding between at an age three and seven years, males at eight years. They give birth to one pup in late May to early July and breed annually due to high reproductive failures (Clakins and Pitcher 1982; NMFS 2008a). There are no Steller sea lion breeding rookeries in Washington waters. According to Jeffries et al. (2000), peak monthly counts indicate that they are most abundant off Washington's coast during March through April and August through November. Prey items include rockfish, skate, hake, salmon, halibut, black cod, squid, and octopus (Pike and Maxwell 1958). A Recovery Plan for the Steller Sea Lion was revised by NMFS in 2008. The plan focuses on rookery performance and protections, and intentional and illegal harvest (NMFS 2008).

4.3.12 Southern Resident Killer Whale (Orca)

Orcas are a long-lived species; up to 80-90 years old for females and 60-70 years old for males. Reproductive males mate with females outside their own pod, but always return to their maternal pod. Most females give birth to their first calf between the ages of 12-17 years, producing a calf on an average of every five to eight years (NMFS, 2008b). Calf mortality is high (37-50% in the first six months). Females average 2.2-4.1 surviving calves over a reproductive life span (Olesiuk et al. 1990, NMFS 2008).

The survival of these whales has been shown to positively correlate with Chinook salmon abundance (Ford et al. 2010). Chinook are apparently the key prey item for resident killer whales (Ford et al. 1998). Indeed, 72.2 percent of the 396 salmon taken by killer whales that were sampled from 1974 to 2004 were Chinook, despite the much higher abundance of the other species (Ford and Ellis 2005).

Southern Resident killer whales are some of the most chemically contaminated marine mammals in the world (second only to north pacific transient killer whales) as a result of their dependence on fish that originate from the industrial shorelines of Puget Sound, Vancouver, and Victoria (Ross 2004; Kriete 2007). These chemicals, which bio-accumulate up the food chain, are still used and continue to leach into the environment; others have been banned but still persist in sediments and the tissue of marine biota. Females tend to have lower levels of contamination than males due to offloading during gestation and lactation. This offloading exposes calves to high levels of toxic chemicals ranging from endocrine disrupters to carcinogens (Ross 2000).

A Recovery Plan for Southern Resident Killer Whale was issued by NMFS in 2008. This plan acknowledges that no one threat can solely be linked to the decline in the population or would have a significant impact on recovery. It points to the need for ongoing research and monitoring needs to address data gaps and answer questions regarding threats (NMFS 2008).

4.3.13 Marbled Murrelet

Marbled murrelets breed in the early spring. Both males and females share the incubation of a single egg. During breeding season and chick rearing phase marbled murrelets will make daily trips between marine feeding areas and their nests in old growth forests, feeding their chicks up to eight times per day. Common prey items are forage fish like sand lance, smelt, and herring (USFWS 1997). All nest locations in Washington have been located in old-growth trees that were greater than 32 inches in diameter at breast height (Ralph et al. 1995). Nests are usually located near the coast, but distances up to 50 miles inland have been found in Washington (Hamer and Nelson 1995). Reproductive success tends to be low, which is largely attributed to high levels of predation as their predators are able to adapt to habitat modifications whereas murrelets are not (USFWS 1997).

A Federal Recovery Plan for Marbled Murrelet was completed in 1997. The plan focuses on the protection of habitat in the terrestrial environment, and acknowledges the need to do so in the marine environment. In addition, it discusses reduction of mortality from the net fisheries, minimizing the occurrence of oil spills, implementing silviculture techniques to speed up development of new habitat, and the need for research and monitoring (USFWS, 1997).

Table 4. Rare, Threatened, and Endangered Species and Their Use of the Nearshore Zone

Species	Federal Listing Status and Date[1]	State Listing[1]	Critical Habitat Status and Date	Recovery Plan	Use of the Puget Sound Nearshore Zone	Dependence on the Nearshore Zone
Northern Abalone	SC	SCan	n/a	n/a	Inhabit rocky shorelines with ample kelp cover around the San Juan Islands and the Strait of Juan de Fuca where they graze on diatoms and kelp.	Direct
Olympia Oyster	None	SCan	n/a	n/a	Oyster reefs are often situated between eelgrass beds and mudflats.	Direct
Bocaccio	E, April 28, 2010	SCan	no	no	Planktonic larvae may drift through the nearshore zone. Juvenile rearing in shallow water over rocky substrate with kelps or sandy bottoms with eelgrass. Juveniles and adults occasionally wander into the nearshore zone for foraging.	Direct
Canary Rockfish	T, April 28, 2010	SCan	no	no	Planktonic larvae may drift through the nearshore zone. Juvenile rearing in shallow sand and/or rocky interfaces and kelp.	Direct
Yelloweye Rockfish	T, April 28, 2010	SCan	no	no	Planktonic larvae may drift through the nearshore zone. Juveniles and adults occasionally wander into the nearshore zone for foraging.	Intermittent
Eulachon	T, March 18, 2010	SCan	no	no	Spawning in natal estuaries. Use of shallow nearshore habitat for foraging, particularly in the northern Sound.	Direct
Hood Canal Summer Chum	T, March 25, 1999	SCan	yes, September 2, 2005	yes	Rearing and smoltification in natal estuaries. Migration and foraging in shallow nearshore areas. Use of coastal embayments for foraging and refuge from predators. Use of natal estuary for acclimatization to freshwater re-entry before upstream migration to spawning grounds.	Direct

Species	Federal Listing Status and Date[1]	State Listing[1]	Critical Habitat Status and Date	Recovery Plan	Use of the Puget Sound Nearshore Zone	Dependence on the Nearshore Zone
Puget Sound Chinook Salmon	T, March 24, 1999	SCan	yes, September 2, 2005	yes	Rearing and smoltification in natal estuaries, migration and foraging in shallow nearshore areas. Use of coastal embayments for foraging and refuge from predators. Use of natal estuary for acclimatization to freshwater re-entry before upstream migration to spawning grounds.	Direct
Puget Sound/ Strait of Georgia Coho	SC	none	n/a	n/a	Rearing and smoltification in natal estuaries, migration and foraging in shallow nearshore areas. Use of natal estuary as adults for acclimatization to freshwater re-entry before migrating upstream to spawning grounds.	Direct
Coastal/ Puget Sound Bull Trout	T, November 1, 1999	SCan	yes, October 18, 2010	yes	Foraging in shallow nearshore areas and estuaries as sub-adults and adults. Use of natal estuary as adults as a migratory corridor to upstream foraging areas and spawning grounds. Use of natal and non-natal estuaries for access to freshwater overwintering habitats.	Direct
Puget Sound Steelhead	T, May 11, 2007	none	no	no	Rearing and smoltification in natal estuaries, migration and foraging in shallow nearshore areas. Use of estuaries as adults for upstream migration.	Direct
Green Sturgeon	T, April 7, 2006	none	yes October 9, 2009	no	Foraging in nearshore and estuarine shallow water for benthic-dwelling prey such as shrimp, mollusks, amphipods, and small fish.	Intermittent

Species	Federal Listing Status and Date[1]	State Listing[1]	Critical Habitat Status and Date	Recovery Plan	Use of the Puget Sound Nearshore Zone	Dependence on the Nearshore Zone
Sea Otter	none	E	n/a	yes	Inhabit the shallow kelp forests of the nearshore zone, which they almost never leave, where they feed on a variety of benthic invertebrates.	Direct
Southern Resident Killer Whales (Orca)	E, November 18, 2005	E	yes, November 29, 2006	yes	Food source is almost 100% salmon at certain times of the year, mostly chum and Chinook, which are highly dependent on the nearshore zone as juveniles. Killer whales play and pursue prey in kelp beds.	Indirect
Humpback Whale	E, December 2, 1970	E	no	yes	The humpback whale is a rare visitor of the inland water of Puget Sound.	Minimal
Marbled Murrelet	T, October 1, 1992	none	yes, October 5, 2011	yes	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.	Indirect
California Buttercup[2]	none	none	n/a	n/a	Grows on open grassy areas and rocky slopes along the shoreline.	Direct
Sharpfruited Peppergrass[2]	none	none	n/a	n/a	Occurs in moist cracks and vernal pools, and sand or saline soil in direct sunlight.	Direct
Golden Paintbrush	T, June 11 1997	none	no	yes	Occurs in open grasslands at elevations below 100 meters around the perimeter of the Puget Sound.	Direct

1. Abbreviations: SC = Species of Concern, T =Threatened, E=Endangered, PT = Proposed Threatened, PE = Proposed Endangered, SCan = State Candidate
2. Identified as rare by the Washington Department of Natural Resources Natural Heritage Website.

4.4 Aquatic Invasive Species Identified as Risks to Puget Sound Ecosystems

The most threatening aquatic invasive animals to Puget Sound restoration efforts are the following (Ray 2005):

- Asian corbula clam (*Pomatocorbula amurensis*)
- Asian date mussel (*Musculista senhousia*)
- Atlantic oyster drill (*Urosalpinx cinerea*)
- Atlantic salmon (*Salmo salar*)
- Boring sponge (*Cliona thoosina*)
- Copepod sp. (*Pseudodiaptomus inopinus*)
- Eastern mud snail (*Nassarius obsoleta*)
- European green crab (*Carcinus maenas*)
- Japanese false cerith (*Batillaria attramentaria*)
- Japanese oyster drill (*Ceratostoma inornatum*)
- Japanese purple varnish clam (*Nuttalia obscurata*)
- Ribbed mussel (*Geukensia demissa*)

There are nine invasive marine plant species present in Washington identified in the Washington State Aquatic Nuisance Species Management Plan (Meacham 2001).

- Diatomaceous algae
  - *Pseudo-nitzchia australis*
- Macro algae
  - Dead man's fingers (*Codium fragile tometosoides*)
  - Japanese weed (*Sargassum muticum*)
  - Lomentaria (*Lomentaria hakodatensis*)
  - Tocoroten red algae (*Gelidium vagum*)
- Vascular plants
  - Common cordgrass (*Spartina anglica*)
  - Saltmeadow cordgrass (*Spartina patens*)
  - Smooth cordgrass (*Spartina alterniflora*)
  - Japanese eelgrass (*Zostera japonica*)

5 Hazardous, Toxic, and Radioactive Waste (HTRW)

The following land use types are known to cause concern for chemical contaminants and these land uses are found in one or more project locations of the Tentatively Selected Plan.

5.1 Stormwater and Urban Runoff

Polluted surface runoff in developed areas is the most common pathway for chemical contaminants to reach Puget Sound. Rain hits the roofs, roads, paved areas, and other hard surfaces and runs into storm drains, then passes mostly untreated into lakes, streams, and

rivers that drain to Puget Sound. The heaviest concentrations of toxic substances come from developed areas of commercial/industrial and residential land uses due to their impervious surfaces such as pavement and roofs, which prevent rainwater from soaking into the ground and allow chemical contaminants to drift away in runoff, and from agricultural runoff.

Urban and homeowner use of pesticides and fertilizers that contain copper contributes up to one-third of the estimated release of copper into Puget Sound. Residential plumbing components leach copper to aquatic ecosystems as well. About another one-third of copper detected in runoff came equally from brake pad wear, roofing materials, and boat paint (WDOE 2011). Other chemicals of concern entering the Sound include flame retardants such as PBDEs, phthalates (a family of chemicals commonly found in plastics and roofing materials), triclopyr (a pesticide commonly used in urban areas), cadmium (from asphalt composite shingles), and zinc. More than 80% of zinc releases come from roofing materials.

Furniture, computer monitors, and other components of residential and commercial indoor environments release PBDEs, which are transported to treatment works as dust particles or runoff (which can then reach Puget Sound through combined sewer overflows). PBDEs were the only chemical of concern for which direct deposition from air appeared to be the largest delivery pathway to Puget Sound.

5.2 Marinas and Ports

More than 170 marinas cover approximately 0.3% (1,483 acres) of Puget Sound shoreline (Pearson et al. 2011b). Recreational boats and small commercial vessels contribute PAHs due to chronic spills, drips, and leaks during fueling and transition into and out of marinas and ports. Vessel anti-fouling paint leaches copper and tributyltin (though banned in 1988) to the water column and sediments. PAHs appeared in relatively high concentrations in phytoplankton from non-urbanized basins, and in particular from samples collected near marinas, ferry terminals, and shoreline roadways (Pearson et al. 2011b).

5.3 Agricultural Areas

Contaminants from agricultural practices include nutrients such as nitrogen and phosphorus commonly found in fertilizers, metals including cadmium and zinc), a variety of insecticides (DDT, DDE, DDD) and herbicides used for agriculture and lawn maintenance, and fecal coliform from livestock. Agricultural pollution in Puget Sound mainly occurs around the large river deltas where former wetland acreage has been converted to farmlands and pasture. Copper-based pesticides and fertilizers are used in agricultural as well as urban applications. Herbicide use on crops and golf courses includes the chemical triclopyr (a broad-leaf herbicide used primarily for rice crops, pasture and rangeland, rights-of-way, and turf, which is permitted under WDOE's Aquatic Pesticide General Permit to control nuisance vegetation in lakes). Agricultural areas produced the highest concentrations for several metals due to historical

releases. Abandoned and current storage tanks, used for fueling farm equipment, are another source of contaminants.

5.4 Commercial/Industrial Areas

Some of the chemical contaminants associated with commercial and industrial discharges and runoff include PCBs from transformers and old paints, sealants and caulks in buildings (PCBs were banned in 1979 and are no longer used), phthalates from various personal care products, petroleum-based contaminants, nonylphenol (a compound often found when commercial detergents break down), and mercury (thermostat and fluorescent lamp disposals), among others. In addition, the weathering of pigments and paints on buildings can contribute cadmium, copper, lead, tributyltin tin, and PCBs to the environment. Wastewater treatment plants are a major pathway for PBDEs, and appear to transport larger annual quantities to Puget Sound than surface runoff. The Asarco Smelter in Tacoma emitted arsenic for decades and may have resulted in large swaths of the Puget Sound area with elevated arsenic. Historically, a large source of mercury to Puget Sound was a now-defunct chloralkali plant in Bellingham, although numerous other industrial and combustion sources still release mercury. Data from 2003 showed that at Fourmile Rock, located near Elliott Bay, mussel tissues had especially high PCB levels in the early 1980s (more than 1,500 parts per billion [ppb] dry weight) followed by a decline to 262 ppb in 2002. This lower level, however, is still more than five times the national median for PCBs in mussels (PSAT 2007a).

5.5 Pulp and Wood Industry

Creosote, a tarry substance formed as coke distillate, is used to preserve wood and has historically been a major source of PAHs in Puget Sound, particularly in areas with pole treating operations adjacent to marine waters. PAHs from creosote-treated wood are detrimental to fish eggs and embryogenesis and can affect early life stages of fish such as herring. Researchers with the Skagit Marine Resources Committee found that 60-year-old pilings were continuing to leach creosote daily into the marine environment; one cubic foot of creosote-treated wood contains at least 20 pounds of creosote (PSAT 2007a). Other sources of PAHs come from wood smoke and vehicle exhaust. Median concentration of PAHs in mussel tissue from Puget Sound sites ranged from 200 to 4,000 ppb dry weight. These concentrations range from one to more than 10 times the national median value of 220 ppm dry weight (PSAT 2007a). Wood treatment facilities also were a historical significant source of arsenic contamination. Pulp mill emissions include lead and dioxins. In the Puget Sound region, the major historical sources of dioxins (PCDD/Fs) are from the use of elemental chlorine in pulp bleaching, pentachlorophenol wood treatment operations, and the combustion of saltwater-infused hog fuel (unprocessed mix of coarse chips of bark and wood fiber) (WDOE 2011).

5.6 Utility Lines

Utility lines include electric and underground fuel bearing lines. Telephone lines historically used creosote-treated poles, many of which remain today including those that either cross stream courses or are adjacent to water bodies. A component of electric lines included transformers that contained PCB liquids, which resulted in releases to the environment due to equipment spills and leakage. Herbicides containing arsenic were applied historically along rights-of-way to control vegetation. PCBs and arsenic likely are still contaminating the sites where they were used.

5.7 Transportation Corridors

Transportation corridors include roadways, commercial vessel corridors, and railroads. Vessel traffic associated with petroleum refining and transportation facilities may release PAHs to the water and sediment. PAH concentrations were relatively high in sediments near Anacortes, an urbanized area in north Puget Sound with significant petroleum refining and transport facilities (PSWQAT 2002). Roadways are a source of petroleum-related compounds from minor fuel and oil spills, and drips and leaks from cars and trucks. Pollutants from roadways can enter the Sound from dust (50% is transported off-roadways as fugitive dust) and stormwater runoff. Chemicals entering the aquatic ecosystem include copper from brake pad abrasion, zinc from vehicle tire abrasion, and incomplete combustion of fuels resulting in atmospheric deposition of contaminants into the marine environment. Incomplete combustion causes releases of arsenic, cadmium, lead, mercury, PAHs, and in some instances dioxins. Creosote-treated wood accounts for one-third of the PAH release, with marine pilings (54 t/yr), railroad ties (43 t/yr), and utility poles (17 t/yr) representing the major sources (WDOE 2011).

6 Summary of Cultural Resources in Puget Sound

Puget Sound has played a vital role in the development and growth of Native American settlement within the Northwest Coast region. Native American tribes relied heavily upon Puget Sound and its vast marine and lacustrine resources as an integral part of their culture by contributing heavily to subsistence strategies as well as transportation and trading routes. Hundreds of prehistoric and historic archaeological sites have been found on the historical shorelines of Puget Sound, providing insight about these coastal-based cultures. Distinguishing characteristics of prehistoric groups include a heavy reliance on abundant marine organisms and anadromous fish, highly skilled woodworking and fishing technology, and complex social organization.

Between 14,000 and 15,000 years ago, the glaciers surrounding the Northwest Coast began to recede, allowing the settlement of the region by migrating people from the north and the south. However, while much of the region was ice free, little, if any, cultural material dates from within this period. Early sites throughout the region are composed primarily of lithic

assemblages that become increasingly complex through time. Due to a lack of faunal material at these sites, it is believed that subsistence strategies during this period focused primarily on terrestrial mammals, with increased reliance on marine food sources over time. The first large shell midden sites date from the period between 5,500 and 3,500 years before present, accompanying an increase in population, a diversification of artifact types, specialized technological adaptations for fishing and marine mammal hunting, woodworking, artwork, and wealth and status objects. This pattern of increased specialization in technology and site composition continued until approximately 1,500 years before present, when artifact diversity began to decline, while Coast Salish structures and cultural practices began to emerge.

6.1 Site Types

An archaeological site can be defined generally as a place where past human activity has left a mark or materials behind. Sites are classified as prehistoric when such activities occurred prior to the advent of written records in a particular area. In Puget Sound, prehistoric sites range from the Paleolithic era (from 15,000 years before present) and continuing until the period of European exploration and colonization initiated in the late 18th century.

Prehistoric site types and frequencies vary through space and time, mirroring changes in subsistence strategies, occupational patterns, and evolving social structure. Throughout the Puget Sound region, sites can generally be broken down into five main types: occupation sites, food processing centers and middens, lithic assemblages, traditional cultural places, and burial grounds.

6.1.1 Occupation Sites

Prehistoric occupation sites include temporary and permanent sites. Temporary sites, such as hunting camps, leave a relatively small archaeological footprint and are characterized by small assemblages that include fire cracked rocks, lithic scatters, and faunal materials. Permanent sites, such as winter villages, leave a large archaeological footprint, and are representative of multi-generational use over an extended period.

The selection of a winter village location depended primarily on topographic considerations and proximity to food and other resources. Due to their dependency on marine and lacustrine resources, Northwest Coast villages were generally located close to a beach or along a river, while riverine villages were most often located at the junction of two river tributaries. Houses in south Puget Sound often were constructed on higher ground to allow for drainage, whereas groups in north Puget Sound constructed winter houses on shores where the beach is full of sand or gravel and where there is a layer of earth to be trodden down as a floor. Villages within Puget Sound generally consisted of several family groups occupying one or more large plank houses and sometimes one or more smaller structures. House floors, consisting primarily of

trampled and pounded earth, may be identified as well as fire hearths or pits and various smaller structures that vary among cultures, seasons, and village populations.

6.1.2 Food Processing Centers and Middens

The most common site type found on the shores of Puget Sound is a midden deposit. Most commonly associated with shell, middens represent domestic subsistence waste and are invaluable in discovering subsistence strategies of prehistoric cultures. In the Puget Sound region, midden deposits are the result of annual harvest preparation and preservation of food for winter storage, as well as a means of immediate food supply.

Salmon was a primary food source for all groups that lived along Puget Sound as well as its tributaries and drainages. The use of other resources to supplement their diet varied among groups. Chinook, coho, chum, pink, steelhead, and sockeye were caught by various methods including spears, gill nets, dip nets, traps, weirs, clubs, hook and line, and gaffs. Salmon either was prepared fresh for immediate consumption or was preserved by smoking over open fires to be stored for winter use. Other fish, such as cod, flounder, perch, skate, trout, smelt, herring, halibut, and sturgeon were used in a variety of different ways.

Shellfish provided an important supplement to native diets in Puget Sound, and were highly prized as trade items as far away as Eastern Washington. Common species found include a variety of clams (horse clam, butter clam, littleneck, cockle, and geoduck), mussels, oysters, and barnacles, all of which were obtained with digging sticks or by hand. Large game, small fur bearing mammals, birds, and marine mammals (porpoise, seal, and whale) were consumed and used, either through opportunistic harvesting or through planned hunts. Plant foods were an important part of native subsistence and health, including herbs, roots, nuts, bulbs, sprouts, berries, and tubers.

6.1.3 Lithic Assemblages

Stones that have been shaped or modified by humans form an important part of the archaeological record within the Pacific Northwest. Archaeological stone tools may be found in isolation, but are most often discovered in a loose association known as an assemblage, and can be made from a variety of materials. Lithic assemblages can consist of tools such as end and side scrapers, weapon points such as arrow and spear heads, fire modified rock, ground stone tools such as mauls and adzes, and manufacturing byproduct known as debitage.

6.1.4 Traditional Cultural Properties

Places of cultural significance, generally termed traditional cultural properties, refer to sites connected to the beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The significance of these traditional places derives from the role the property plays in a community's historically

rooted beliefs, customs, and practices. Examples include locations with artistic, religious, and ceremonial significance to Native American groups such as treaty locations, and locations associated with aboriginal stories.

6.1.5 Burial Grounds

A burial can be described as a deliberate deposit or final stage in a funerary ritual that is likely to result in the placement of human remains. While individual inhumation sites and group cemeteries are most likely to manifest themselves archaeologically, excarnations such as above ground canoe burials were also present within the Puget Sound region.

6.2 Historic Resources

In common with other frontier regions in the Pacific Northwest, explorers and fur traders made the first non-native expeditions to the Puget Sound region. British explorer George Vancouver led the way in 1792. British and American fur traders infrequently worked the Puget Sound before the British-owned Hudson Bay Company made the first non-native structural presence, a trading post and stockade built on the Sound's southern shores. In the early 1850s, Euro-Americans started venturing into the Puget Sound region in increased numbers. The draw for most was the region's vast forests of giant fir, spruce, cedar, and hardwoods, building materials that were in high demand down the Pacific Coast at the burgeoning California city of San Francisco. In 1852, the fledgling settlement that became Seattle took root at the Sound's premier inlet, Elliot Bay. A lumber mill was in operation at Seattle within a year, and logging camps and mills soon dotted the landscape throughout the region.

Agriculture settlement and production in the Puget Sound region also took hold in the early 1850s. The timber industry significantly aided early agricultural activities as loggers cleared fertile bottomlands of trees. Many loggers and mill workers turned to subsistence farming as means to feed their family. By the mid-1860s, only a few settlers had looked to the low-lying river deltas, estuaries, and sloughs along the coast as potential farmland. Preparing those otherwise swampy tidal lands for agricultural uses required the construction of ditches and earthen dikes to drain and hold back rising tides and the seasonal floodwater of rivers. Once converted, tidal lands proved ideal for pasturing cattle and raising high-yield fodder crops of oats and hay. Draining and diking of tidal lands at a larger scale waited until the 1870s when most of the prime upland agricultural area had been taken.

While timber was the primary industry and agriculture was second, other endeavors contributed to early economic and population growth in the Puget Sound region. Commercial fishermen heavily exploited the natural bounty of salmon and shellfish, and processed and packaged their catches locally for shipment to San Francisco and other distant markets. By 1880, Seattle and Tacoma supported shipyards that used local lumber to construct maritime

vessels as well as small steamers and other boats suited to ferrying people, cargo, and mail to and from waterfront communities around the Sound.

Agricultural activities in the Puget Sound region began to shift to meet the demands of a growing urban population. Dairy farming became increasing prevalent aided, in part, by the introduction of new technologies for processing milk. Reclaimed tidal lands, where oats and hay grew in abundance, almost exclusively became devoted to dairy farming. By 1920, dairying ranked as the primary agriculture activity in Puget Sound and Western Washington.

A network of roads and highways started to evolve around the region after the introduction of the automobile in the first decade of the twentieth century. Compared to other parts of Washington, progress moved slowly. The late 1920s and early 1930s saw the completion of two major highway systems, which together encircle the entire Puget Sound coastline—the Pacific Coast Highway and Highway 101.

Examples of Puget Sound's current collection of historic buildings and structures are listed below. Examples are limited to just the broad categories of function or use most common to tidal lands: industry, agriculture, and transportation.

- Port Gamble Historic District. A logging and milling community containing one of Puget Sound's oldest collections of buildings and structures, dating to 1853.
- Salina Fisheries Company Cannery, Anacortes. A salmon cannery initially constructed in the mid- to late-1910s.
- John and Annie Larson Farm House, Livingston Bay, Camano Island. Constructed in 1891.
- Deepwater Slough Dikes, Island County. System of earthen agricultural dikes, developed between 1885 and 1909.
- Steilacoom Creek (Northern Pacific) Railroad Bridge, Chamber Bay, Steilacoom vicinity. The only surviving vertical-lift bridge of the Strauss design in the nation, constructed in 1913-14.
- North and South Hamma Hamma River Bridges, Old US Highway 101, Eldon vicinity. Two rainbow arch concrete bridges, constructed in 1924.

7 Future Risk Assessment Approach and Assumptions

7.1 Projected Scenarios for Land Development

Three future scenarios for land development—Status Quo, Managed Growth, and Unconstrained Growth—were applied to Puget Sound and examined using the ENVISION computer modeling program. These scenarios, described in Error! Reference source not found., were developed to examine what is considered the range of realistic possible future conditions. The ENVISION analysis was conducted to provide projections for the most-expected land-development scenario (Status Quo), as well as for two additional scenarios that generally

represent the range of differences that could occur if more stringent (Managed Growth) or more lax (Unconstrained Growth) land management policies were in place. In the modeling simulations, researchers held human population growth constant among the scenarios while applying a different set of development-policy rules for each of the three scenarios to allocate development across each Puget Sound sub-basin.

Table 5. ENVISION Puget Sound Scenarios Descriptions (Bolte and Vache 2010)

Scenario	Description
Status Quo	This scenario reflects a continuation of current trends in the region. In this scenario, continuation of current policies would allow moderate levels of development in most areas. No development would be allowed on deltas, within floodplains, or in areas with unstable slopes; development on wetlands would be limited. This development pattern would emphasize moderate density uses.
Managed Growth	This scenario reflects the adoption of an aggressive set of land use management policies focusing on protecting and restoring ecosystem function and concentrating growth within Urban Growth Areas (UGA) and near regional growth centers. No new development would be allowed within 200 feet of the shoreline. Outside the 200-foot zone, development would be severely restricted in areas near sensitive lands, including current and historical wetlands, lands with significant conservation opportunities, deltas, unstable slopes, or lands adjacent to streams. Water views would be protected. In developed areas, the focus would be on increasing density.
Unmanaged Growth	This scenario models a relaxation of current land use restrictions, with limited protection of ecosystem functions. The Unmanaged Growth scenario would allow significant new development in the nearshore zone. No development is allowed on deltas or on unstable slopes, but other landforms would be developable. This development pattern would emphasize low-density uses.

ENVISION was used to allocate the projected population growth in 10-year (decadal) time increments under each of the three land development scenarios. These population estimates were in turn used as inputs for modeling subsequent effects on land use/land cover. The projected population growth is expected to lead to an expansion of developed areas in the Nearshore Study area. Changes in distribution and amounts of a subset of shoreline attributes were also projected.

7.2 Assumptions in the Forecast of Process Degradation

7.2.1 Landform Transition Assumptions

- No Landform Transitions are Included in the Future Projections. The transition of one natural landform type (e.g., bluff-backed beach, barrier estuary) to another natural landform type or an artificial landform type is the result of either significant landscape-scale modification of the processes sustaining a given landform or the construction of several stressors that cumulatively function to completely change the shoreline configuration and character. Landforms resulting from the latter type of landform transitions are termed artificial landforms. Observations from

the analysis of landform changes, from historical to current, indicate that nearly 92% of the landform transitions (665 of 719) involved transition from a natural landform to an artificial landform or became absent. It is assumed that new shoreline alterations on the scale necessary to cause transitions to artificial landforms are unlikely because of a combination of more restrictive regulatory controls than were in place historically and increased community resistance to such projects. That is, major alterations leading to transitions of landforms, from natural to artificial or absent, in the Puget Sound nearshore zone are largely a legacy of previous actions. While transitions from one natural landform type to another natural landform type could occur because of long-term degradation of landform-forming processes, these transitions were rare historically (54 transitions between historical and current). If this assumption, that there will be no new landform transitions, is incorrect, then it is reasonable to assume that landform transitions will occur in association with existing stressors or forecasted shoreline armoring.

7.2.2 Shoreline Alterations Assumptions

- Shoreline alterations in the future are adequately estimated by the forecasted distributions of armoring, marinas (subset of overwater structures), and wetland losses. All of the other types of shoreline alterations (additions of tidal barriers, breakwaters/jetties, nearshore fill, roads, railroads) are either unlikely to occur in large quantities and/or if they do occur they will be co-located with one of the stressors that is forecasted to expand or already exists.
- Few if any new tidal barrier structures will be constructed. If any are constructed, it is assumed they will be co-located with increases in armoring or wetland loss. Construction of barriers to tidal inundation (dikes and levees) is strongly regulated by Federal and State laws, due to the impacts on high-value coastal wetlands.
- Breakwaters/jetties are often constructed to protect marinas. It is assumed that any new breakwaters/jetties will be co-located with a new marina and/or existing or new armoring.
- Placement of new nearshore fill for purposes of access or land reclamation will not be widespread due to the increased scrutiny and enforcement of regulations intended to restrict such actions. If this assumption is incorrect, it is likely that any new areas of fill will be co-located with future or existing shoreline armoring. Material may be placed for purposes of beach or bank nourishment.
- Widespread extension of nearshore roads (within 80 feet of shoreline) will not occur. Assuming very limited expansion of nearshore roads is questionable, but unavoidable. A satisfactory approach to projecting the Sound-wide distributions of new nearshore roads was not identified. If another model or method of projecting expansion of road network is identified at a later stage of the study, this assumption may be revisited, and process degradation that includes calculation of nearshore roads re-evaluated. While some road relocations are proposed as

features in the final array of alternatives, they are not anticipated to be within 80 feet of the shoreline and are intended to restore nearshore processes, not impede them.

- No increase in railroad distribution along the nearshore zone will occur. This assumption was applied because railroads already span long stretches of shoreline, and regulatory agencies and the community would exert strong resistance. At present, although there is pressure to increase rail traffic in Puget Sound in support of coal and oil production, there have been no definite plans from Burlington Northern Santa Fe (BNSF) Railroad for the addition of rail lines. However, rail lines are experiencing increased traffic and upgrades to existing rail lines are taking place. If this assumption is incorrect, then it is assumed that the shorelines with new railroads would be characterized adequately by the projected new armoring and/or stressors already along the shoreline. Because of how the evaluation framework is designed, the co-location of any future railroads with other stressors means that the associated process degradation will be included in the analysis despite the absence of future railroad data.
- The conversion of tidal wetlands to conditions that fall within a developed land cover category will result in lost wetlands. A projection for loss of tidal wetlands was created based on this assumption. Land cover data from Bolte and Vache (2010) were used to identify areas of tidal wetlands that are forecasted to be converted to developed lands. These areas were calculated as the area of lost wetlands in the analysis of the future. The rationale for this scenario is based on the observation that the regulatory environment of Washington does not fully prevent wetland loss due to development. It is true that if wetlands are impacted then compensatory mitigation is required. However, the habitat functions of a restored wetland do not immediately match the functions of a natural wetland and sometimes never achieve comparable function (Stevens and Vanbianchi 1993; Johnson et al. 2002). Furthermore, enforcement of wetland mitigation is a discretionary expenditure of the regulating agencies and only covers a small fraction of all development permits. The assumption of lost wetlands with development is based on the uncertainty of successful wetland mitigation as well as lack of enforcement. The implications of an overestimate of wetland loss will not result in overstatement of the proposed project benefits because such benefits are based on the area added by a given project, not a percentage change from existing wetland area.

7.2.3 Adjacent Uplands and Watershed Area Assumptions

- Forecasts of impervious surfaces are in preparation. Impervious surfaces (e.g., roads, roofs) in the adjacent uplands and watershed area are included in the evaluation of nearshore processes. Bolte and Vache (2010) are preparing an impervious surfaces dataset that could be included in the Preconstruction, Engineering and Design (PED) phase if warranted. The data from the change analysis were applied to the degradation projections.

- Forecasts of stream crossings may be included in PED. Stream crossings in the watershed area are included in the evaluation of nearshore processes. A projection of stream crossings can be prepared when a roads model is created (see above). The data from the change analysis were applied to the future degradation analysis.
- No new dams will be constructed. It is anticipated that regulatory requirements and community resistance will reduce the possibility of new dams. The data from the change analysis were applied to the degradation projections.

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PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX G

ECOSYSTEM OUTPUT MODEL

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps of Engineers®
Seattle District

PUGET SOUND NEARSHORE ECOSYSTEM OUTPUT MODEL DOCUMENTATION REPORT

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

Prepared in Support of Puget Sound Nearshore Ecosystem Restoration Project

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1 INTRODUCTION

This report documents the methodology for quantitatively estimating the ecological benefits that could be realized through implementation of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). Quantification of ecological benefits is accomplished typically through the application of a model. This report describes the model for evaluating potential achievement of restoration objectives for the PSNERP (PSNERP Ecosystem Output model), and how the model was developed.

A benefits model should measure the level of performance, raise awareness and understanding, measure progress toward programmatic goals, and support decision making. Models can be quantitative (e.g., length), semi-quantitative (e.g., long, longer, longest), non-quantitative (e.g., color), or nominal (e.g., yes or no); however, U.S. Army Corps of Engineers (USACE) policy requires that restoration projects only use models that are "expressed quantitatively" (ER 1105-2-100 [USACE 2000]). Throughout this report, the term "ecosystem output" is synonymous with "ecological benefit" for the purpose of quantifying anticipated positive outcomes of proposed restoration actions.

Through a collaborative effort, an interdisciplinary sub-group of the PSNERP team including: USACE staff, Washington Department of Fish and Wildlife (WDFW; the non-Federal sponsor), contractor support staff, and Nearshore Science Team (NST) members, has created the PSNERP Ecosystem Output model described in this report.

2 MODEL REQUIREMENTS

The USACE defines the purpose of ecological restoration as "to restore significant ecosystem function, structure, and dynamic processes that have been degraded" (ER 1165-2-501 [USACE 1999a]). The goal is to restore ecological resources of "significance," with significance generally being defined subjectively as a measure of quality and/or institutional or public recognition. In USACE projects, ecosystem resources are generally expressed quantitatively either in physical units (acres, for example) or with indices that are surrogates for functions or processes. According to USACE policy guidance, "Ecosystem structure is the state and spatial distribution of material forms within the ecosystem at a specified time. It includes microscopic and macroscopic material components in diverse living and non-living assemblages. Ecosystem functions are the dynamic cycling of inputs and outputs characterized by rate and direction of change in material and energy flows through time and space. Ecosystem functions redistribute components of structure through abiotic (non-living) and biotic (living) processes" (EP 1165-2-502 [USACE 1999b]).

Within programs of the USACE, models can quantify ecological benefits at multiple scales, including the project, regional, and national scales of the following benefits considerations (ER 1105-2-100):

- *Comparison of project alternatives*– How do ecosystem restoration planners compare ecological benefits of alternative restoration measures and plans (e.g., fish bypasses, ladders, or lifts at a given location)?
- *Development of project performance assessment and success criteria* – Following implementation, is the project successfully accomplishing objectives?
- *Adaptive management of project outcomes* – Are the monitoring plan and metrics appropriate for identifying problems and adaptively managing deficiencies?
- *Regional programmatic assessment and portfolio management* – How do managers prioritize and manage multiple, smaller projects to achieve objectives in large-scale, system-wide efforts (e.g., the Comprehensive Everglades Restoration Plan)?
- *National programmatic assessment and portfolio management* – How do managers prioritize and budget projects and track results to achieve goals at a national scale?

"Ecosystem restoration outputs must be clearly identified and quantified in appropriate units" (ER 1105-2-100). Ecological benefits can be estimated using area restored as a surrogate index, as in a known quantity used as an indicator for an unknown value. This is

problematic, however, because area is not a measure that accounts for the quality or the relative value of a specific restoration action at a given location. Models that measure one or more ecosystem outputs can estimate project benefits more accurately than models that estimate only the amount of area restored. USACE restoration planning documents often express direct outputs in terms of either simple abundance (e.g., how many fish are in a given river reach) or index-based values (e.g., habitat units). USACE policy does not emphasize a preferred model or model type to measure performance, but instead states, "All relevant ecosystem components need to be described and assessed" (EP 1165-2-502 [USACE 1999b]). Selection of outputs, units, and techniques for quantification is challenging because, for each problem, there are many types of metrics, or performance measurement equivalencies, that could be applied; however, mission objectives and USACE policy provide some guidance for the use of metrics and development of models.

Given that the purpose of the USACE Ecosystem Restoration mission is "to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition" (ER 1105-2-100 [USACE 2000]), indices and metrics that capture aspects of structure, function, and process are obvious candidates for use in an ecosystem output model.

USACE policy states that single-species approaches should be discouraged as they narrow the breadth of benefits potentially provided, and community-based approaches are preferred (ER 1105-2-100). Furthermore, USACE guidance has traditionally favored habitat-based approaches, stating "habitat-based evaluation methodologies, supplemented with production, user-day, population census, and/or other appropriate information, shall be used to the extent possible to describe and evaluate ecological resources and impacts associated with alternative plans" (ER 1105-2-100). Habitat focus, however, tends to limit the number of species analyzed and is not as holistic as incorporating more ecosystem components than habitat needs of one or a few species. Alternative approaches may include other physical measurement metrics (e.g., spatial characteristics, community structure, or water quality conditions) or ones that may be more function- or process-based (e.g., bank retreat, organic matter breakdown). Function- and process-based metrics of ecological condition are often highlighted as underused measurements of the state of an ecosystem (Young et al. 2008).

Effective metrics have the following characteristics, as documented by several authors including Roy (1985) and Yoe (2002):

- **Scientifically verifiable** – Two independent assessments would yield similar results.

- **Cost-effective** – The technology required to generate data for the metric is economically feasible and would not require an intensive deployment of labor.
- **Easy to communicate to a wide audience** – The public would understand the scale and context and be able to interpret the metric with little additional explanation.
- **Changeable by human intervention** – The metric would have a causal relationship between the state of the system and the variables that are under a decision maker's control. Metrics that are independent of human action do not inform a management, policy-making, or design process.
- **Credible** – Most stakeholders would perceive the metric as accurately measuring what it is intended to measure.
- **Scalable** – The metric would be directional, whether qualitative (best, good, worst) or quantitative, as appropriate.
- **Relevant** – The metric would reflect the priorities of the public and other stakeholders and enhance the ability of managers and regulators to execute faithfully their stewardship responsibilities.
- **Sensitive** – The metric would be sensitive enough to capture the minimum meaningful level of change or make the smallest distinctions that are still significant, and it would have uncertainty bounds that are easy to communicate.
- **Minimally redundant** – What the metric measures is not duplicating another metric in the set being used.
- **Transparent** – Use of the metric does not create or promote any "secret agenda."

The purpose of the PSNERP Ecosystem Output model is to provide quantification of the potential ecological improvement of proposed restoration actions so that the actions can be compared against each other, and to compare alternative suites of actions at the Sound-wide scale; the goal for the model is to have the characteristics listed above along with achieving the purpose. This contributes to the planning effort by quantifying the benefits of the actions, allowing comparison of action benefits to the "Future Without Project" condition, and serving as a screening tool for selecting actions from those that are proposed and evaluated.

3 PSNERP APPROACH TO MODEL BUILDING

The team, charged with inventing a way to estimate the ecological benefits of nearshore restoration actions, wanted to move beyond the simplistic single-species, index-based, or habitat-focused models. The goal was to express the expected improvement of restoring process, structure, and function in a more holistic approach based in sound science. The resulting PSNERP Ecosystem Output model is a synthesis of much of the work done throughout the general investigation.

3.1 Theoretical Basis for Conceptual Model

The PSNERP Ecosystem Output model accounts for both quantity and quality. Quantity is accounted for as number of acres restored. The quality portion of the model includes considerations of process, structure, and function. These are the three conceptual components of the model that together describe the relationship of ecosystem components to ecological goods and services (Figure 1). In this conceptual model, **processes** are the dynamic abiotic (i.e., physical and chemical) cycles and interactions that create and sustain other ecosystem components, specifically structure and function. Examples of processes include sediment delivery and transport, tidal hydrology, and detritus import and export. **Structures** are the stationary abiotic and biotic attributes of an ecosystem. Examples of structures are distributions of shoreform types, beach substrate, and aquatic vegetation composition. **Functions** include interactions between organisms and their physical environment, as well as other ecosystem goods and services including nutrient cycling, food web support, and water quality.

The theory behind the development of this model is that processes, structures, and functions all contribute to ecosystem goods and services. Ecosystem goods and services are the diverse benefits that humans enjoy, consume, or use from ecosystems (MEA 2005). A simple example of this relationship is common on Puget Sound beaches and embayments: sediments from bluff-backed beaches deposited at small creek mouths (natural process) form barrier spits that partially enclose estuaries and lagoons (natural structure) that in turn provide habitat for clams (ecological function). Clams are at the consumer base of the food web, and provide food to humans (ecological good), and filter nutrients from the water column (ecological service).

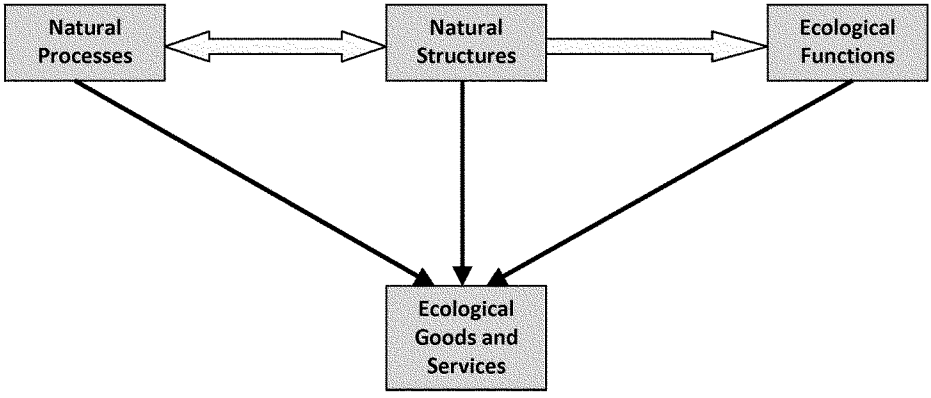

Figure 1. Conceptual Model of Linkages between Processes, Structures, and Functions and Ecological Goods and Services.

Modified from Gelfenbaum et al. (2006) and Simenstad et al. (2006)

3.2 Benefits Measurement Concept

Much of the PSNERP general investigation work has been an analysis aimed at characterizing problems of Puget Sound's nearshore ecosystems, identifying restoration objectives, and identifying management measures to achieve those objectives. To that end, two separate tools have been developed to characterize the degree to which anthropogenic changes to the nearshore have affected the capacity for ecological processes to support ecosystem functions, goods, and services (EFG&S). These two tools are quantification of process degradation, and quantification of impairment of EFG&S. The process evaluation framework is described in the strategic needs assessment report ([SNAR]; Schlenger et al. 2011), and the EFG&S impairment metric is described in the change analysis report (Simenstad et al. 2011). These two tools are used to characterize different components of the conceptual model represented in Figure 1. The PSNERP Ecosystem Output model incorporates these process degradation and EFG&S impairment analysis tools in assessment of ecological benefits for USACE planning purposes.

The process evaluation framework characterizes the capacity of shoreline process units (SPUs) and delta process units (DPUs) to support nearshore processes; process evaluation and degradation are described in the SNAR (Schlenger et al. 2011).

The assessment of EFG&S impairment is presented in the change analysis report (Simenstad et al. 2011), which documents Puget Sound shoreline changes between the late 1800s and the present. The EFG&S analysis applies the following four categories of goods and services, which are classified in the Millennium Ecosystem Assessment report (MEA 2005) and the World Resources Institute report (WRI 2005):

1. **Regulating services** such as the regulation of climate, floods, disease, wastes, and air and water quality
2. **Supporting services** such as soil formation, photosynthesis, and nutrient cycling
3. **Provisioning services** such as food, water, timber, fuel, and fiber
4. **Cultural services** such as educational, recreational, aesthetic, and spiritual benefits

The EFG&S impairment as calculated in the change analysis report (Simenstad et al. 2011) characterizes changes to the ecological functions and the human-focused goods and services. During the PSNERP Feasibility Scoping Meeting on May 6, 2010, USACE Headquarters provided guidance that the human-focused inputs of provisioning and cultural services do not meet the purpose of the USACE ecosystem restoration mission. Corps policy (ER 1165-2-501) on the ecosystem restoration mission area states, "Projects implemented under this guidance should address the restoration of ecosystems, i.e., ecological resources, and not restoration of cultural and historic resources, aesthetic resources, or cleanup of hazardous and toxic wastes." Therefore, the EFG&S impairment analysis tool provided in the change analysis report was modified for use in this ecosystem output model by isolating the broader ecological category inputs (regulating and supporting) from the human-focused inputs (provisioning and cultural) so that calculations could be designed to include only the ecological category inputs.

In addition to process and function, the ecosystem output model includes a characterization of structure. The structural benefit indices focus on landscape-scale distributions of shoreforms[1]. The five aspects of landscape structure are (1) shoreform scarcity, (2) shoreform heterogeneity, (3) shoreline sinuosity, (4) longshore connectivity, and (5) cross-shore connectivity. Indices used to quantify these five aspects, detailed in section 4.3.2, were developed through workshops and close coordination with members of the NST.

3.3 Aligning Model Components with Planning Objectives

Four PSNERP planning objectives were identified, with no intended prioritization, in a problem statement that was informed by two documents mentioned earlier: 1) a strategic needs assessment report (SNAR; Schlenger et al. 2011), which identifies areas of degraded processes and functions in the Puget Sound nearshore zone based on interpretations of historic change in the shoreline, and 2) the change analysis report (Simenstad et al. 2011), in which historic shoreline conditions from the late 1800s are compared to shoreline conditions circa 2006. These objectives, along with their sub-objectives, are listed below. Planning objectives 1 through 3 describe restoration, and planning objective 4 describes monitoring and adaptive management.

1. Restore the size and quality of large river deltas

    a. Restore tidal flow and inundation area in river deltas
    b. Restore quality and quantity of tidal wetlands in river deltas with emphasis on oligohaline and tidal freshwater wetlands
    c. Improve connectivity between the nearshore and adjacent uplands/ watershed
    d. Increase the shoreline length of large river deltas

2. Restore the number and quality of coastal embayments

    a. Restore embayment shoreline length that has been reduced through fill placement
    b. Restore embayments that have transitioned to an artificial shoreform or have been lost through conversion to uplands
    c. Restore existing embayments that have been degraded
    d. Restore quality and quantity tidal wetlands in coastal embayments

3. Restore the size and quality of beaches

    a. Restore sediment input processes by reducing degradation of bluff-backed beaches in divergence zones and transport zones of sediment drift cells
    b. Improve sediment transport and accretion processes by removing subtidal and intertidal stressors contributing to shoreline degradation

4. Increase understanding of natural processes in order to improve effectiveness of program action

    a. Gather and analyze data to inform adaptive management and ensure project success
    b. Gather and analyze data to inform future restoration efforts by the Corps and others

The metrics and indices that are the components of the quality portion of the ecosystem output model (process, structure, and function) are based on these objectives. (See section 4 for discussion of the quality and quantity portions of the model.)

3.4 Overview of PSNERP Spatial Scales

Four spatial scales are used in this PSNERP study:

- Puget Sound – includes the Puget Sound, the Strait of Juan de Fuca, and southern portions of the Strait of Georgia that occur within the borders of the United States
- Sub-basins – PSNERP-defined divisions of Puget Sound based on geographic features including oceanographic sills and bathymetry, the common issues and interests of the entities in these areas, and the water that flows into and within the Sound
- Process Units – from the change analysis report (Simenstad et al. 2011)
    - Delta process units (DPUs) – characterized by the large river deltas, and their associated drainages, that encompass varying salinity and flooding regimes
    - Shoreline process units (SPUs) – individual littoral drift cells that drive sediment delivery and transport along the shore to accretionary features or discharge offshore
- Action – refers to a specific restoration management measure or a combination thereof, within a site, with a single non-Federal sponsor (i.e., a separable element).

Different indices are calculated at different scales (e.g., process unit or sub-basin scale) depending on which scale is most appropriate.

3.5 Data Source and Software Applications Used for Measurements and Calculations

The ecosystem output calculations are generated from the project's geodatabase, which contains information on the physical conditions along the shoreline and throughout the upland drainage areas. The geodatabase includes all parameters necessary to calculate each component of the ecosystem output model such as area, length, number, and deviation from a straight line (for sinuosity). These are calculated using the following types of data from the geodatabase:

- Geographic spatial units (GSUs) that define drainage areas contributing to specified portions of the shoreline
- Shoreline alignment
- Shoreline stressor distributions and dimensions (e.g., shoreline armoring and nearshore fill)
- Upland stressor distributions and dimensions (e.g., impervious surfaces and land development)
- Tidal wetland distributions and dimensions by wetland class
- Shoreform types, locations, and dimensions
- Shoreline process unit (SPU) and delta process unit (DPU) delineations

Information is either provided or calculated for historic, current, and post-restoration, as appropriate for each parameter. To limit complexity of the ecosystem output model and to maximize its usability and transparency, the only software needed is ArcGIS® for measuring features present on the landscape and Excel for calculating formulas. Since calculations rely on "off-the-shelf" software, no special programming is required to perform the benefits calculations.

4 PSNERP ECOSYSTEM OUTPUT MODEL COMPONENTS

The primary equation of the PSNERP Ecosystem Output model, presented in section 4.1, was progressively developed and tested in several iterations. It is based on the following general equation:

Ecosystem Output (EO) = Quantity x Quality

Where:

Quantity – Area (described in Section 4.2)

Quality – Components: process, structure, and function (described in Section 4.3)

When the ecosystem output model is used to evaluate individual actions, ecological benefits are calculated at the process unit scale; process units are operationally defined by littoral drift cells (SPUs) or large deltas (DPUs). This ecosystem output model works at multiple scales; evaluations may be conducted that compare and rank individual sites, full alternatives within the seven sub-basins defined for PSNERP, or at the Sound-wide scale. The inputs to the model are either data or data derivatives from a geospatial information system (GIS) geodatabase.

4.1 Development of the Ecosystem Output Equation

Following is the final form of the primary equation in the PSNERP Ecosystem Output model. Each of the equation elements is based on one of the four types of model parameters: Area (A), process (P), structure (S), or function (F). The equation is used to measure potential ecological benefits of proposed restoration actions.

$EO = A^* [(P^2 + S + F)/\text{maximum possible score}]$

Where:

EO – ecosystem output

A – area of restored process, in acres or other areal units (Quantity score)

P – process degradation index score, 0 – 10

S – summation of landscape indices, 0 – 10

F – EFG&S Tier 2 impairment score, 0 – 10

Maximum possible score: 120

Quality score: $(P^2 + S + F)/\text{maximum possible score}$

The following sections describe the equation components in more detail and discuss how they were refined for this purpose through several iterations of development and testing.

Each component has a score on a 0 – 10 scale. Each component is composed of one or more indices, which are described in more detail in section 3.5. For a detailed description of the set of calculations the equation is based on, see Appendix A. Each of the three variables — process, structure , and function—represents a piece of the information about the quality of the area, and the score for any one of these components does not modify the score for any other individual component; therefore, they are additive so that together they modify the area component.

Initially, an equation with different weighting was proposed (discussed in section 5.1). After testing the initial equation on a suite of proposed restoration actions, including the 36 that have undergone 10% design, the team discovered that the area component explained more than 90% of the variance of the ecosystem output values; i.e., the measurements of quality (process, structure, function) were not contributing enough to the calculated ecosystem outputs to be meaningful components. Another component that was initially considered, ancillary benefits (E), was contributing very little and therefore it was excluded from calculation of ecological benefits. This undue dominance of area on the ecosystem outputs and under-representation of the quality components led to the refined equation presented above that is ultimately used in the model. The new equation represents the following rationale regarding the importance of components:

- The ecosystem output model results should be sensitive to both quantity and quality components in the equation.
- The process component of quality is weighted most heavily because the PSNERP intent is to ensure sustainability by restoring the nearshore processes, so the weighting of the process component needs to be strong enough to influence the ranking of the proposed actions.
- The structure and function components of quality shall contribute equally to the ecosystem output, but less than the process component does.
- The final quality score is represented by a proportion that will be multiplied by area. A quality score of 1.0 indicates the maximum quality that could be achieved by the action.

Alternate methods of weighting the process component were considered. One way would have been to multiply the other components by small fractions (e.g., 0.1 or 0.02); however, results showed that, with this method, the process component did not affect the quality score enough to make any statement about improving the quality of a large area. Therefore, using only the area of restoration would have dominated the entire EO score and the quality portion would have had no effect. Ultimately, the team chose the commonly applied weighting method of squaring the most important component—in this case, process—so that it has a greater influence on the final score; in this case, the EO.

Based on a Spearman's Rank Correlation Test, the quality portion of the equation affects the total score such that outcome (EO score) and rank are not based solely on the area of the proposed action; actions that would restore more process score higher.

For each index described in the following sections, scores have been calculated for two scenarios of "Future With Project" conditions (partial restoration and full restoration) and for the corresponding scenarios of "Future Without Project" conditions (without partial and without full restoration), for conceptual designs of 36 proposed actions. For the "Future Without Project" conditions, the team has elected to use the inventory of current conditions. This is a conservative estimate, which assumes zero degradation, although the more likely case would be further degradation of the nearshore ecosystem due to the predicted population increase in the Puget Sound area over the next 50 years. Additional stressors from this population increase, however, could be mitigated through environmental regulations and permitting requirements. Since it is not possible to predict exact population increases, their effects on the nearshore, or changes in environmental regulations, the assumption is made that the existing stressors will remain unchanged for the period of analysis.

Finally, per USACE planning guidance, average annual net benefit will be used for cost effectiveness/incremental cost analyses (CE/ICA) and is calculated as follows:

Net EO = (EO "With Project" conditions – EO "Future Without Project" conditions) * Average Annual Benefit Factor

4.2 Area Component

Traditionally, USACE has used the quantity and quality of habitat jointly, in the form of habitat units, to measure structural improvements provided by ecosystem restoration

projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The PSNERP Ecosystem Output model uses acres, delineated by polygons, to represent the quantity portion of the equation. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated.

Three different scales of area were considered for quantification of PSNERP management measures to determine which would be the most suitable area metric to use in the model. For each scale, the capabilities and limitations were considered.

- **Action footprint** –A measurement of the physical footprint of the management measures (for example, the area where vegetation is planted or the footprint of a removed berm). When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlap areas addressed by two or more management measures.
  - Capability – Can be accurately quantified with a high degree of certainty
  - Limitation – May grossly underestimate the areal extent of ecological benefits from each management measure because process restoration covers a broader area

- **Area of restored process** – This is a measurement of the area directly affected by the restoration of process. For areas where armor is removed to restore sediment input, the area is measured along the length of the shoreline where armor is removed for length and from the top of the bluff to the mean lower low water (MLLW) level for width, but the measurement does not extend down-drift. For areas where tidal inundation is restored, the measurement extends up-gradient to include the total tidally inundated area regardless of salinity level.
  - Capability – Can be accurately quantified with high level of certainty for some management measures (for example, those that restore tidal inundation), and more fully captures the area that would experience ecological benefits from restoration of a process
  - Limitation – Difficult to quantify with certainty for some management measures (for example, those management measures that restore sediment transport and delivery); does not identify whether an action is too small to have a significant benefit to the ecosystem

- **Potential area of influence** – This is a measurement of the area that could benefit from the process restoration provided by the action. In some cases, this may be the same as the area of restored process. In other cases, it could extend beyond the area of restored process to the greater ecosystem area that a stressor affects; indirect effects can extend well beyond the immediate area of stressor removal. While potential area of influence is an estimated area that is more consistent with the guidance calling for a systems approach (ER 1165-2-501), it was not feasible to devise consistent rules for defining this area. For instance, an increase in primary productivity has an effect across a much larger spatial area than just the area where new aquatic vegetation is placed; however, the affected area would be difficult to quantify systematically.
  - Capability – Fully captures the area of ecological benefits of a given management measure
  - Limitation – Not feasible to estimate with any degree of certainty and consistency

To develop definitions of all three scales of area for each of the 21 management measures, as defined in Clancy et al. (2009), a workshop was conducted. Through the workshop discussion and follow-up, it was determined that, of the three scales considered, using area of restored process is the optimal approach to estimating ecological benefits beyond the specific action footprint with the least amount of uncertainty. The action footprint was considered to provide too significant an underestimate. Estimating the potential area of influence scale was considered too uncertain and speculative.

To define the area of restored process for each management measure at the proposed action locations, the target processes for each management measure were identified at the action scale. The proposed management measures that restore process, and the area of restored process for each, are in Table 1. The proposed management measures that do not directly address process and their target areas of restoration are in Table 2.

Table 1. Management Measures that Restore Process and Area of Restored Process

Management Measure	Primary Process Restored	Area of Restored Process
Armor Removal or Modification	Sediment input	Applicable to divergence zones and transport zones of drift cells: a polygon defined by the length of the shoreline where armor is removed or modified multiplied by the distance between the top of the bluff and mean lower low water (MLLW) Applicable to convergence zones and shorelines of no appreciable drift: footprint of the armor removed or modified
Berm or Dike Removal or Modification	Tidal hydrology via inundation	Area where tidal inundation is restored
Channel Rehabilitation or Creation	Tidal channel formation and maintenance, and distributary channel migration	Area where tidal inundation is restored
Groin Removal or Modification	Sediment transport and wave energy	Length squared plus the footprint
Hydraulic Modification	Tidal hydrology via energy and freshwater input	Tidally inundated area
Overwater Structure Removal or Modification	Solar radiation	Footprint of the overwater structure removed or modified, plus any additional area shaded by the structure
Revegetation	Vegetation processes	Area planted plus area shaded by the vegetation
Topography Restoration	Beach shoreline: topographic processes	Area of fill removed
	Embayment and wetland: tidal hydrology via inundation	Area where tidal inundation is restored

Table 2. Management Measures that Do Not Directly Address Process

Management Measure	Category [a]	Primary Process Restored	Area of Restored Process
Beach Nourishment	Enhancement	NA	Footprint of the substrate placement
Contaminant Removal	Prerequisite	NA	Footprint of removal
Debris Removal	Prerequisite	NA	Footprint of removal
Habitat Protection and Policy Regulation	Protective	NA	For habitat protection, footprint of the area being protected
Invasive Species Control	Enhancement	NA	Area of removal
Large Wood Placement	Enhancement	NA	Footprint of the large wood
Physical Exclusion (fences, barriers, etc. to exclude human or animal use)	Prerequisite	NA	Footprint of the exclusion area
Pollution Control	Prerequisite	NA	Difficult to accurately quantify an area that would benefit from pollution control, action specific
Property Acquisition and Conservation	Prerequisite and Protective	NA	Area of acquisition or conservation
Public Education and Involvement	Protective	NA	NA
Species Habitat Enhancement	Enhancement	Species lifecycle	Species specific
Reintroduction of Native Animals	Enhancement	Species lifecycle	Species specific
Substrate Modification	Enhancement	NA	Footprint of the substrate placement

Notes:
NA Not applicable
a Defined in Clancy et al. 2009

4.3 Quality-Component Indices

Indices to quantify the ecological benefits of the process, structure, and function components were developed with input from the NST. In July 2010, the concepts of these indices were presented to the NST. In August 2010, members of the NST, the project management team, and the USACE planning team, as well as USACE employees from the Engineer Research and Development Center (ERDC) and other districts with expertise in developing ecosystem output models for use in plan formulation of USACE projects, participated in a two-day workshop to develop indices for the quality-component. During the workshop, formulas for

calculating each of these indices were proposed. Since then the ecosystem output team has worked on refining these formulas, through weekly meetings and occasional workshops and discussions with NST members. The following sections describe the indices and their development.

4.3.1 Process

As already described, processes are the ecosystem cycles and interactions that create and sustain other ecosystem components; specifically, structure and function. The nearshore processes that influence the marine and estuarine shorelines of Puget Sound occur and vary over diverse spatial and temporal scales (Simenstad et al. 2011). The process index (P) addresses all of the PSNERP objectives (see section 3.3) by measuring the removal of stressors that impede the processes that shape and sustain river deltas, embayments and beaches, . The PSNERP assessment of nearshore ecosystem conditions focuses on the broad physiographic processes that can be considered landscape-forming processes. The NST identified the following 11 broad ecosystem processes as being most important for the creation, maintenance, and function of Puget Sound's shoreline (Simenstad et al. 2011). To characterize the effects of shoreline and watershed alterations (or stressors) on nearshore ecosystem processes, the NST used a simplified version of an evaluation framework developed in the SNAR (Schlenger et al. 2011). These effects are termed "process degradation." Process degradation is evaluated with a separate metric for each of the processes at the scale of process units (10 processes in SPUs and 10 processes in DPUs). Process degradation is estimated by measuring the percent of a process unit with one or more stressors present in areas where a process would occur. Following are the 11 processes:

- Sediment input - calculated as the length of the shoreline with one or more stressors divided by total shoreline length
- Sediment transport - calculated as the length of the shoreline with one or more stressors divided by total shoreline length
- Erosion and accretion of sediments - calculated as the length of the shoreline with one or more stressors divided by total shoreline length
- Tidal flow - calculated as the area of inundation divided by area of inundation if all stressors were removed
- Distributary channel migration - calculated as the length of the shoreline with one or more stressors divided by total shoreline length (applies to DPUs only)

- Tidal channel formation and maintenance - calculated as the tidal wetland area divided by the historic tidal wetland area
- Freshwater input - For DPUs: calculated as the area downstream of the lowermost dam divided by the total area. For SPUs: calculated as the area in adjacent upland with ten percent or more impervious surface divided by the total area in adjacent upland
- Detritus import and export - calculated as the length of the shoreline with one or more stressors divided by total shoreline length
- Exchange of aquatic organisms - calculated as the length of the shoreline with one or more stressors divided by total shoreline length
- Physical disturbance - calculated as the length of the shoreline with one or more stressors divided by total shoreline length (applies to SPUs only)
- Solar incidence - calculated as the aquatic area with overwater structures divided by the total aquatic area.

Only ten of these eleven processes apply to any given process unit. The distributary channel migration process does not apply to SPUs, and the physical disturbance process does not apply to DPUs. Stressors that affect these processes include the following:

- Wetland loss
- Armoring
- Jetties and groins
- Tidal barriers such as dikes and levees
- Overwater structures
- Fill
- Marinas
- Roads
- Railroads

Different stressors are considered for each of the processes. For example, armoring, roads, fill, and railroads in SPUs apply to the sediment-input degradation process. So, if there are one or more of these stressors along 50% of the shoreline (by length) where sediment input occurs, then the process degradation score for sediment input within that process unit is 0.5. The overall process degradation score is the sum of the individual degradation scores for all the process within an action area.

The calculation methodology for process degradation is as follows:

- Calculate degradation of each process at the action scale
- Sum the scores for the various processes
- **Apply the formula:**
  P = Process Degradation,

$$P = 10 - \sum_{i=1}^{10} D$$

Where:

D = the degradation of each process

While: $10 - D \begin{Bmatrix} 10 \\ 0 \end{Bmatrix}$: 0 = fully degraded, and 10 = not degraded (no stressors present)

- **Data needs**: Current degradation scores from the SNAR framework (Schlenger et al. 2011), and post-project degradation scores, which are calculated by estimating the percent of process that will still be degraded after the construction process removes some amount of stressors.
- **Identified issues/concerns:**
  - Are certain process degradation scores co-dependent?
  - The assumption is that all processes are of equal value within a process unit, because determining primary or dominant processes would largely be subjective.

The raw process degradation scores (D) are on a scale of 0 to 1000 (the sum of each of the ten process-degradation percentages at a given action). Values are divided by 100 to get them on a 0 to 10 scale, and then subtracted from 10 to reflect higher scores for less process degradation. "Future Without Project" condition is represented by existing degradation scores; "With Project" condition is represented by post-action degradation scores, after stressor(s) have been removed from the shoreline through application of management measures. See the accompanying Excel spreadsheet that demonstrates how P is calculated.

4.3.2 Structure

The general PSNERP definition of structure is the complex pattern of shoreforms that make up the Puget Sound shoreline. Nearshore processes have affected the shape and the formation of these shoreforms that are largely the result of significant geologic events that occurred long ago. For the purpose of the ecosystem output model, structural benefits are quantified with indices that measure how actions contribute to restoration of the historic landscape patterns of shoreforms. These indices, taken from the study of landscape ecology, include scarcity, heterogeneity, sinuosity, longshore connectivity, and cross-shore connectivity, which are described in more detail in the following sections. The structure indices do not attempt to predict a quantity of post-project benefits, but rather provide a pre-project score to support decisions on whether to take action at a particular geographic location. The objective for the structure component is to increase the score for actions that address certain characteristics of nearshore structures. The following equation represents the structure component:

S = Structure,

$$S = 2 (Sc + H + Lc + Cc + Sn)$$

Where:

Sc = scarcity

H = heterogeneity

Lc = longshore connectivity

Cc = cross-shore connectivity

Sn = sinuosity

Structure is on a scale of 0 to 10. For this to occur, because each individual index is on a scale of 0 to 1 and there are five indices, the sum of values for the five indices is multiplied by 2. For a "Future Without Project" score for each action, the indices in this component of the model do not attempt to predict what the condition would be, but rather they remain at zero to provide no credit for no action. For calculation of four of the five indices that comprise the structure score, these do not predict the beneficial outcome of taking an action, but rather

provide a credit for taking action for the "With Project" condition, and zero credit for no action, or the "Without Project" condition. The exception is heterogeneity, discussed in more detail below. The team sees this as a way to encourage the right project at the right location, which is one of the Project's restoration strategies.

4.3.2.1 Scarcity

The objective of the scarcity index is to assign higher scores to actions that restore wetland types and shoreforms that were historically rare *and* that are now at a fraction of their historic occurrence. These scarce shoreforms are often of high ecological value. This index addresses PSNERP planning objectives 1 and 2 as it will favor actions that will restore scarce wetland types in river deltas and embayments. If an action takes place in a scarce shoreform or wetland zone (regardless of whether it is creating a lost shoreform or improving one that still exists), it will affect the value for this index. Scarcity index values are calculated and assigned to each shoreform at the sub-basin scale since this index is not very sensitive at the process unit scale; therefore, the scarcity index of a given shoreform/wetland type differs among sub-basins. Table 3 shows example calculations for scarcity of shoreforms in one of the seven sub-basins. If there is no change in count of shoreform type between historic and current conditions, or if shoreform count increased from historic to current conditions, then the [|(C-H)/H|] value is zero or rounded to zero. This increases an action's score for working in a scarce shoreform without decreasing its score for working in a shoreform that is not scarce. The calculation methodology is as follows:

- **Apply the formula:**

  Sc = Scarcity Index

$$\text{Scarcity Index} = [|(C-H)/H|] * [1-(H/T)]$$

  Where:

  C = current occurrence of a shoreform by count within a basin, or current wetland zone by area within a basin

  H = historic occurrence a of shoreform by count within a basin, or historic wetland zone by area within a basin

  T = total count of all historic shoreforms within a basin, or total historic wetland area within a basin

While: $Sc\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = low scarcity shoreform, and 1 = highly scarce shoreform

- **Data needs:** Historic and current occurrence of shoreforms by count within a basin and historic and current wetland zone areas within a basin.

The scarcity index is on a scale of 0 to 1. The value of this index is 0 for "Future Without Project" condition as no credit is given if there is no restoration action. For many actions there is more than one shoreform type; in these cases, the highest scarcity index is assigned. Table 3 gives examples of how scarcity is calculated.

Table 3. Example Calculations for the Scarcity Index

SUBBASIN	Shoreform Class	Shoreform_Type	CountOfHistID	CountOfCurrID	(c-h)/h	|(c-h)/h|	h/t	1-(h/t)	Soreform Scarcity Index |(c-h)/h| * [1-(h/t)]
SC	Beaches	BLB	170	163	-0.04	0.04	0.34	0.66	0.03
SC	Beaches	BAB	160	136	-0.15	0.15	0.32	0.68	0.10
SC	Embayments	BE	39	27	-0.31	0.31	0.08	0.92	0.28
SC	Embayments	BL	31	10	-0.68	0.68	0.06	0.94	0.64
SC	Embayments	CLM	41	5	-0.88	0.88	0.08	0.92	0.81
SC	Embayments	OCI	31	24	-0.23	0.23	0.06	0.94	0.21
SC	Rocky Shores	RP	22	21	-0.05	0.05	0.04	0.96	0.04
SC	Rocky Shores	PB	10	10	0	0	0.02	0.98	0.00
	TOTAL without Artifical or Delta		**504**	**396**					

SUBBASIN	Wetland_Zone		Hist_Area	Curr_Area	(c-h)/h	|(c-h)/h|	h/t	1-(h/t)	Wetland Scarcity Index |(c-h)/h| * [1-(h/t)]
SC	EM	EM	18781324.96	3113631.44	-0.83	0.83	0.22	0.78	0.65
SC	EU	EU	60375948.17	45046381.37	-0.25	0.25	0.72	0.28	0.07
SC	OT	OT	380021.03	60867.17	-0.84	0.84	0.00	1.00	0.84
SC	TF	TF	4614405.34	3402.12	-1.00	1.00	0.05	0.95	0.94
SC	Unclassified								
		TOTAL	**84,151,700**	**48,224,282**					

4.3.2.2 Heterogeneity

The objective of the heterogeneity index is to assign higher scores to actions that contribute to restoring the historic diversity of shoreforms. This index measures the composition and abundance (diversity) of shoreform types within a geographic area. It does not capture arrangement of shoreforms. This index addresses PSNERP planning objectives 1,2, and 3; a

variety of shoreforms and wetland types along the shoreline is useful because the diversity and richness of natural shoreforms in Puget Sound will provide many habitat types and niches for nearshore species to occupy. Heterogeneity is calculated by shoreform length at the sub-basin scale since this index is not very sensitive within a process unit. Increases in heterogeneity due to artificial shoreforms are not valued for this index; therefore, artificial shoreforms are left out during calculations. Historic heterogeneity is the target because it is not PSNERP's intent to "create" heterogeneity along the shoreline in areas where there was none historically. Heterogeneity levels that are greater than historic reach an apex score as being equal to historic (no additional value is given to actions that increase heterogeneity levels above that of historic conditions).

The calculation methodology is as follows:

- Determine the natural shoreform lengths of each shoreform type in a sub-basin.
- Use the Shannon Weiner Diversity Index to determine heterogeneity.
- Apply the formula:

  H = Heterogeneity,

$$H = -\sum_{i=1}^{Sh}(p_i \ln p_i)$$

Where:

Sh = the number of shoreforms in a sub-basin

p_i = the proportion of each shoreform (by length) in a sub-basin (shoreform length divided by total shoreline length)

For current conditions: current shoreform lengths will be divided by current total shoreline length

For post-action conditions: post-action shoreforms lengths will be divided by 1) the post-action total shoreline length if it is greater than the current total shoreline length; or 2) the current total shoreline length if the post-action total shoreline length is less than the current total shoreline length

While: $H\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = no heterogeneity (dominated by one shoreform), and 1 = high heterogeneity (many types of shoreforms).

- **Data needs**: Shoreform counts by length in sub-basins and Puget Sound.
- **Identified Issues**: The heterogeneity index value may not change (or may change only slightly) when evaluating post-project conditions of one action because this index is calculated at the sub-basin scale. Use of this index may be more appropriate when evaluating a suite of actions within a geographic unit rather than an individual action.

The ln used in the formula will often result in a negative number, thus the absolute value will be used. Raw heterogeneity values are on a scale of 0 to infinity. Because there is no upper limit of potential heterogeneity, the highest ranking score in the dataset will be used. For the 36 actions proposed the highest score is 2. The values are normalized to a scale of 0 to 1 by multiplying by 0.5. The current heterogeneity index value is used for "Future Without Project" conditions, and the post-action heterogeneity value is used for "With Project" conditions, thereby providing an assessment of how a project increases heterogeneity. Table 4 gives example calculations for heterogeneity.

Table 4. Example Calculations for Heterogeneity

Shoreform Type	Current length	Subtract Action Area existing length	Add restoration length	Post action length	Full Proportion	Ln (Curr proportion)	Prop * Ln(proportion)	Sum (Prop* Ln (proportion)	Absolute value of sum	Final Hetreogeneity: multiply by 0.5 to get on scale of 0--->1
Bluff-Backed Beach	217435.045			217435.045	0.511	-0.671	-0.343	-1.629	1.629	0.815
Barrier Beach	59364.846			59364.846	0.140	-1.969	-0.275			
Delta	35555.420			35555.420	0.084	-2.482	-0.207			
Barrier Estuary	44146.117	1994.724		42151.393	0.099	-2.312	-0.229			
Barrier Lagoon	14827.917			14827.917	0.035	-3.356	-0.117			
Closed Lagoon/Marsh	10333.607			10333.607	0.024	-3.717	-0.090			
Open Coastal Inlet	15834.647	1395.038	3375.436	17815.045	0.042	-3.173	-0.133			
Plunging Rocky Shoreline	6660.090			6660.090	0.016	-4.157	-0.065			
Rocky Platform	18178.052			18178.052	0.043	-3.153	-0.135			
Pocket Beach	2986.759			2986.759	0.007	-4.959	-0.035			
SUM	**425322.498**	**3389.761**	**3375.436**	**425308.173**						

4.3.2.3 Sinuosity

The objective of the sinuosity index is to assign higher scores to actions that are located in process units that were historically sinuous. This index measures how much the shoreline length of a particular process unit deviates from a straight line. Sinuosity quantifies how an action will add to the length and complexity of the Puget Sound shoreline (addressing planning objectives 1,2, and 3), providing a variety of habitat types for nearshore species. The Puget Sound shoreline length has declined approximately 15 percent from historic conditions (Simenstad et al. 2011). Thus, actions in historically more sinuous process units are preferable to those in historically simpler process units. A sinuosity index value is calculated for each process unit in Puget Sound; then values for all process units within the same sub-basin are compared. The calculation methodology is as follows:

- Calculate the sinuosity index value of a process unit using GIS tools
- Assign the sinuosity index value to the actions based on the process unit in which they are located.
- **Apply the formula**

  Sn = Sinuosity

$$Sn = \frac{[(HisL_{PU} / HisSL_{PU}) - (\text{Min } (HisL/HisSL)_{SB})]}{[\text{Max } (HisL_{pu}/HisSL_{pu})_{SB} - \text{Min } (HisL_{pu}/HisSL_{pu})_{SB}]}$$

Where:

$HisL_{PU}$= Historic length of the process unit a candidate action is in

$HisSL_{PU}$ = Historic straight-line length of the process unit a candidate action is in

$\text{Min } (HisL_{pu}/HisSL_{pu})_{SB}$ = The process unit with the minimum ratio of historic length to straight-line length among PUs in the sub-basin the candidate action is in

$\text{Max } (HisL_{pu}/HisSL_{pu})_{SB}$ = The process unit with the maximum ratio of historic length to straight-line length among PUs in the sub-basin the candidate action is in

While: $Sn \begin{Bmatrix} 1 \\ 0 \end{Bmatrix}$: 0 = lowest sinuosity PU in a sub-basin

and 1 = highest sinuosity PU in a sub-basin

- Data needs: Historic sinuosity of:
  - the process unit a candidate action is in;
  - process unit with the maximum historic sinuosity within the sub-basin the candidate action is in; and
  - process unit with the minimum historic sinuosity within the sub-basin the candidate action is in.

- Identified Issues:
  - This index does not include closed marsh lagoons, which are not part of the shoreline, but may be part of a restoration action.

Sinuosity is on a scale of 0 to 1. The value of this index is 0 for "Future Without Project" condition, as no credit is given if there is no restoration action. Table 5 gives example sinuosity calculations.

Table 5. Example Sinuosity Calculation

Candidate Action	SPU	Current Straight Line Length of PU (m)	Historic Shoreline Length (m)	ACTION PU HisLpu/ HisSLpu	Sub-basin	PU with Minimum HisLps/	Current Straight Line Length of PU that	Historic Shoreline Length of PU that has the	MINIMUM PU HisLpu/HisS Lpu in SUB-BASIN	PU with Maximum HisLps/HisS Lpu in Sub-basin	Current Straight Line Length of PU that has the	Historic Shoreline Length of PU that has the	MAXIMUM PU HisLpu/HisSL pu in SUB-BASIN	Numerator	Denomenator	Final Sinuosity
Beaconsfield Feeder Bluff Restoration	4015	10,527	12,803	1.22	SC	4034	6,335	6,772	1.07	4031	221	6,133	27.77	0.147	26.700	0.006
Big Beef Causeway Replacement and Estuary Restoration	2088	7,848	14,244	1.81	HC	2038	3,693	3,999	1.08	2010	676	6,641	9.82	0.732	8.740	0.084
Big Quilcene River Delta	2056	3,950	7,091	1.8	HC	2038	3,693	3,999	1.08	2010	676	6,641	9.82	0.712	8.740	0.082
Chambers Bay Estuarine and Riparin Enhancement	3002	6,730	10,459	1.55	SP	3190	1,110	1,271	1.14	3003	202	6,312	31.21	0.409	30.063	0.014
Chuckanut Estuary Restoration	7161	10,142	26,659	2.63	SJ	7157	5,672	6,516	1.15	7053	1,465	41,047	28.02	1.480	26.871	0.055
Deepwater Slough Phase 2	SKG	25,416	224,130	8.82	WH	8055	35,800	42,844	1.2	6037	295	4,472	15.17	7.622	13.974	0.545
Deer Harbor Estuary Restoration	7055	6,668	43,873	6.58	SJ	7157	5,672	6,516	1.15	7053	1,465	41,047	28.02	5.431	26.871	0.202
Deschutes River Estuary Restoration	DES	1,562	18,614	11.92	SP	3190	1,110	1,271	1.14	3003	202	6,312	31.21	10.774	30.063	0.358

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4.3.2.4 *Longshore Connectivity*

The objective of the longshore connectivity index is to assign higher scores to actions adjacent to low degradation process units *and* actions that have degradation values more similar to those of their neighbors, so that longer stretches of low-degradation shoreline result from the action. This index compares the degradation scores of adjacent process units to the degradation score of the process unit in which the action would occur. Actions where adjacent process unit have lower degradation and have degradation scores that are more similar to those of adjacent process units receive a higher value for this index. The Puget Sound shoreline has become fragmented due to anthropogenic stressors, and large areas of intact natural habitat tend to be more ecologically valuable than the sum of individual fragmented segments. The index addresses all four PSNERP objectives; favoring the restoration of shoreforms in continuous stretches (1-3) so they will be more effective at restoring Nearshore processes (4). The calculation methodology is as follows:

- Obtain degradation scores for adjacent process units.
- **Apply the formula:**
  C_{LS} = Longshore Connectivity,

$$C_{LS} = \frac{2(1-D)}{\text{Max}\{(1-D_L), (1-D_R)\} + P_{pot}}$$

Where:

D = current degradation score of the process unit the action is located in.

Max $\{(1-D_L), (1-D_R)\}$ = the higher of the degradation scores for the two adjacent (left and right) process units

P_{pot} = the maximum potential degradation score

While: $CLS\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = degradation score for the action's process unit is highly dissimilar from the score for adjacent process units, and adjacent process units' values are much lower than the degradation score of the action's process unit; 1 = degradation score of the action's process unit is the same as for adjacent process units, and adjacent process units' degradation score (D) is low.

- **Data needs:** Degradation scores for: 1) the process unit in which the action is located, and 2) the process units adjacent to the the action's process unit (process units to the left and right)

Raw degradation scores (D) are on a scale 0-1000. They are scaled from 0-1 by dividing by 1000, and then subtracted from 1 (1-D) to reflect a higher value for less process degradation. The value of this index is 0 for "Future Without Project" conditions because no credit is given if there is no restoration action. Values greater than 1 indicate the process unit the action is in is has a much better score than its neighboring process unit, which is not ideal. To address this issue, any amount greater than 1 will be subtracted from 1 (e.g. a score of 1.2 becomes 0.8). Table 6 gives example longshore connectivity calculations.

Table 6. Example Longshore Connectivity Calculation

Candidate Action	Process Units	Degradation (D) on scale 0 to 1	1-D	FORMULA NUMERATOR 2(1-D)	Max adjacent PU	Max(1-D)adj	Maximum Potential Score for Process (i.e., no degradation)	FORMULA DENOMINATOR	FORMULA CALCULATION (CIs raw score)	FINAL CIs SCORE
Beaconsfield Feeder Bluff Restoration	SPU 4015	0.71	0.290	0.580	4014	0.461	1	1.461	0.397	0.397
Big Beef Causeway Replacement and Estuary Restoration	SPU 2088	0.515	0.485	0.970	2080	0.810	1	1.810	0.536	0.536
Big Quilcene River Delta	SPU 2056	0.085	0.915	1.830	2055	0.965	1	1.965	0.931	0.931
Chambers Bay Estuarine and Riparian Enhancement	SPU 3002	0.757	0.243	0.486	3001	0.273	1	1.273	0.382	0.382
Chuckanut Estuary Restoration	SPU 7161	0.531	0.469	0.938	SAM	0.456	1	1.456	0.644	0.644
Deepwater Slough Phase 2	Delta SKG	0.547	0.453	0.906	6036	1.000	1	2.000	0.453	0.453
Deer Harbor Estuary Restoration	SPU 7055	0.261	0.739	1.478	7056	0.984	1	1.984	0.745	0.745
Deschutes River Estuary Restoration	Delta DES	0.866	0.134	0.268	3042	0.436	1	1.436	0.187	0.187

4.3.2.5 Cross-shore Connectivity

The objective of the cross-shore connectivity index is to assign higher scores to actions adjacent to undeveloped uplands that increase the likelihood of restoration success. This index evaluates an action's proximity to non-degraded areas upland of an action. Therefore, actions located adjacent to relatively pristine uplands receive a higher value for this index. This excludes open water due to the assumption that stressors are not entering the nearshore zone from the waterward side of the action, and that all open water functions the same across all proposed actions and therefore should have no bearing on the connectivity score. The size of the 1000-foot buffer provides more information about the adjacent land than merely using the immediate border area. In this case, "connectivity" is not used to measure access for species; it is intended to show the characteristics of the adjacent uplands that may influence the nearshore. Areas connected to undeveloped lands are more ecologically valuable for restoration than those adjacent to degraded sites; hence this index addresses all 4 PSNERP planning objectives, by ensuring greater success of restoring shoreform types and the Nearshore processes that create and sustain them. The following land use types in the geodatabase are considered undeveloped:

- Emergent Herbaceous Wetlands
- Woody Wetlands
- Herbaceous
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Scrub/Shrub
- Open Water
- Perennial Snow/Ice
- Cultivated Crops
- Hay/Pasture
- Barren Land

The calculation methodology is as follows:

- Using GIS tools, estimate land use classified as undeveloped within a 1000-foot border along an action boundary.

- **Apply the formula:**
  C_{cs} = Cross-shore Connectivity,

$$C_{cs} = \frac{\text{undeveloped land area that borders the landward portion of an action}}{\text{total land area that borders the landward portion of an action}}$$

While: $Ccs\{^{1}_{0}\}$: 0 = no lands bordering the action are undeveloped;
and 1 = all lands bordering the action are undeveloped

- **Data needs:** Land use data from the geodatabase.

This index is on a scale of 0 to 1, as it is a percentage thus requires no modification. The value of this index is 0 for "Future Without Project" conditions because no credit is given if there is no restoration action. Table 7 gives example calculations for cross-shore connectivity.

Table 7. Example Cross-shore Connectivity Calculations

Candicate Action	Developed Area in 1000' buffer	Undeveloped Area in 1000' buffer	Total Area	CROSS-SHORE CONNECTIVITY (% Undeveloped land within 1000' buffer of ActionArea)	Final Ccs Scaled 0-1
Deschutes River Estuary	2268436	475767	2744203	17.3370	0.1734
Duckabush Causeway Replacement and Estuary Restoration	488881	1233110	1721991	71.6100	0.7161
Hamma Hamma Causeway Replacement and Estuary Restoration	159801	1125418	1285219	87.5660	0.8757
Nooksack River Estuary	1789948	8585525	10375473	82.7480	0.8275
Big Quilcene River Delta	259506	3476763	3736268	93.0540	0.9305
Militown Island	223484	1993462	2216946	89.9190	0.8992
McGlinn Island Causeway	60215	606018	666232	90.9620	0.9096

4.3.3 Function

Ecological function is the interaction between organisms and their physical environment, including activities such as nutrient cycling, food web support, and water filtering, which result in the production of ecosystem goods and services. The function component of the ecosystem output equation is represented by F, and is quantified by estimating the impairment of EFG&S along the shoreline using the EFG&S Tier 2 impairment score from the change analysis report (see Simenstad et al. 2011). This index evaluates the expected

change (improvement) in the delivery of EFG&S as shoreline stressors are removed. The EFG&S Tier 2 index increases the ecosystem output value for actions with stressor-removal or wetlands-restoration that result in the greatest improvement in Tier 2 EFG&S impairment scores. The EFG&S index has been modified from the version used in the Change Analysis report to omit human-derived goods and services from the calculation, per USACE Headquarters' request and USACE policy for the national ecosystem restoration mission. The modification entails removing scores for the provisioning and cultural categories from the EFG&S impairment calculation (see Table 8). Values for this index are calculated at the action scale. This action addresses PSNERP planning objectives 1-3; river deltas, embayments, and beaches all provide ecosystem goods, functions, and services. The calculation methodology is as follows:

- Use raw EFG&S ranked scores for regulating and supporting categories (second to last row of Table 8).
- Normalize the raw EFG&S scores to scale of 0 to 1 by dividing each rank by 13 (last row of table 8).
- To get impairment scores, multiply the normalized EFG&S scores by the proportion of shoreline with stressors length (compared to total shoreline length) or the proportion of area with stressors (compared to total aquatic area), OR by wetland area loss or gain compared to historic conditions. Current total shoreline length is used for "With" and "Without Project" conditions so that if the post-project shoreline length is reduced, impairment scores do not increase. Length and area are calculated as follows:

  For stressors:

  - "Without Project" conditions = (Current stressor length / current total shoreline length) OR (Current stressor area / current total aquatic area)
  - "With Project" conditions = (Post project stressor length / current total shoreline length) OR (Post project stressor area / post-project total aquatic area)

  For wetland zones:

  - "Without Project" conditions = (Current wetland area - historic wetland area) divided by historic wetland area

- "With Project" conditions = (Post project wetland area - historic wetland area) divided by historic wetland area

- **Apply the formula:**
  F = Tier 2 EFG&S Impairment

$$F = \sum_{i=1}^{13} I$$

Where:

I= Tier 2 EFG&S Impairment scores (modified) for regulating and supporting categories

While: $F\begin{Bmatrix}10\\0\end{Bmatrix}$: 0 = complete impairment and wetland loss, and 10 = no impairment and/or 100 percent wetland gain in all four wetland classes

- **Data needs:** Tier 2 EFG&S ranks for regulating and supporting, total stressor lengths or areas, total shoreline length or aquatic area, or wetland area in the action area pre-action and post-action.

Scaling:

The Tier 2 EFG&S impairment raw scores for an action will usually be negative. The minimum possible raw score for EFG&S impairment is - 7.462, described as follows:

- 100% stressor length and wetland loss * the normalized maximum rank sum for the 9 stressors and 4 wetland categories.

The maximum possible raw score for EFG&S impairment is 3.233, described as follows:

- No stressors present (all 0%) + [100% increase in all 4 wetland types * sum of the normalized rank value of the 4 wetland types (3.233)].

Note that percent stressor length or area and percent wetland loss are reflected as negative numbers, and percent wetland gains are reflected as positive numbers. The absolute value of -7.462 (the lowest potential score), referred to as the positive scaling constant, will be added to all EFG&S raw values to make the scores positive. So an action with an impairment score of -7.462 will be reflected as a 0. To get scores on a 0-10 scale values are multiplied by:

- 0.935, calculated as 10/[3.233 + 7.462 (scaling constant)]

The denominator reflects the maximum EFG&S impairment value possible after the positive scaling constant is applied. See Table 9 for example EFG&S impairment calculations.

Nearshore Science Team rank of stressors and loss of wetlands across rows for a particular EFG&S (1-13)

Table 8. EFG&S Scores with Provisioning and Cultural Categories Removed

	EFG&S	Loss of: Wetlands (marine => tidal freshwater)				Addition of:								
		Euryhaline (unvegetated mud/sandflat)	Estuarine mixing	Oligohaline transition	Tidal fresh water	Armoring	Breakwaters & Jetties	Tidal Barriers (levees, dikes)	Overwater Structures	Fill	Marinas	Roads	Railroads: Active	Railroads: Abandoned
Regulating	Air quality regulation	4	10	12	13	1	2	6	3	8	7	11	9	5
	Global Climate	6	11	12	13	1	2	10	3	9	8	7	5	4
	Regional and local Climate	7	11	12	13	3	2	5	1	10	8	9	6	4
	Water (quantity)	5	10	11	13	2	3	12	1	8	4	9	7	6
	Water purification and waste treatment- quality	9	11	12	13	2	3	10	1	8	7	6	5	4
	Disease	2	6	11	13	3	4	7	1	8	10	12	9	5
	Pests	3	11	12	13	4	2	10	1	7	8	9	6	5
	Pollination	1	11	12	13	3	4	8	2	10	6	9	7	5
	Natural Hazards	2	11	12	13	8	6	9	1	10	3	7	5	4
Supporting	Nutrient Cycling	12	11	12	13	4	6	9	2	8	7	5	3	1
	Soil Formation	10	13	11	12	9	5	8	1	7	2	6	4	3
	Food Web	9	11	12	13	7	2	5	4	10	8	6	3	1
	Photosynthesis	6	11	13	12	2	4	9	10	7	8	5	3	1
	Sediment Supply	3	5	6	4	13	10	7	2	9	1	11	12	8
RANK SUM		79	143	160	171	62	55	115	33	119	87	112	84	56
RANK		5	11	12	13	4	2	9	1	10	7	8	6	3
Normalized values		0.462	0.836	0.936	1	0.363	0.322	0.673	0.193	0.696	0.509	0.655	0.491	0.327

Scores highlighted in orange are the highest ranking (13) and scores highlighted in blue are the lowest ranking (1).

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Table 9. Example calculations for EFG&S Index

	0.462	0.836	0.936	1.000	0.363	0.322	0.673	0.193	0.696	0.509	0.655	0.491	0.327			
Action Name	**% Wetland Gain/Loss Euryhaline unvegetated[1]**	**% Wetland Gain/Loss Estuarine mixing**	**% Wetland Gain/Loss Oligohaline transition**	**% Wetland Gain/Loss Tidal freshwater**	**Armoring Length by Total Shoreline Length**	**BW/J Length by Total Shoreline Length**	**Tidal Barrier Length by Total Shoreline Length**	**OWS Area by Total Aquatic Area**	**Nearshore Fill Area by Total Aquatic Area**	**Marina Area by Total Aquatic Area**	**Road Length by Total Shoreline Length**	**Railroads-Active Length by Total Shoreline Length**	**Railroads-Abandoned Length by Total Shoreline Length**	**SUM across rows (across Action Area)**	**add 7.462 to get positive numbers**	**Final F score: scale from 0 to 10 by multiplying by 10/max potential, which = 0.0935**
Deschutes River	-0.459	0	0	0	-0.303	0	-0.385	-0.002	-0.020	-0.012	-0.464	0	0	-1.643	5.819	5.440
Duckabush	-0.105	0.251	-0.069	-1	-0.013	0	-0.139	0	-0.007	0	-0.133	0	0	-1.216	6.246	5.840
Hamma Hamma	-0.015	0.230	-0.665	-1	-0.002	0	-0.051	0	0	0	-0.099	0	0	-1.601	5.861	5.479
Nooksack	-0.279	-0.101	-0.903	-0.956	-0.071	-0.027	-0.248	0	0	0	-0.165	0	0	-2.751	4.711	4.405
Big Quilcene-Combine	-0.449	0.836	-0.804	1	0	0	-0.178	0	0	0	-0.002	0	0	0.403	7.865	7.354
Milltown Island	-0.068	-0.394	-0.917	1	0	0	-0.269	0	0	0	0	0	0	-0.648	6.814	6.370
McGlinn Island	-0.348	0.752	-0.379	0	-0.059	-0.079	-0.330	0	-0.009	0	-0.007	0	0	-0.460	7.002	6.546
Deepwater Slough Pha	0	0	-0.923	-0.802	0	0	-0.832	0	0	0	-0.008	0	0	-2.565	4.897	4.578
North Fork Skagit	0	-0.795	-0.936	-0.370	0	0	-0.458	0	0	0	-0.002	0	0	-2.560	4.902	4.583

[1]- Euryhaline wetlands can only be delineated for Delta Process Units because the deeper edge of mud- and sandflats were inconsistent for Shoreline Process Units. Although the geodatabase gives a calculated value for Sediment Process Units, the team was not confident in the estimation from historical data and decided to not include euryhaline unvegetated percent change in any analysis. Therefore a score of zero is given for percent euryhaline unvegetated gain/loss for actions within Sediment Process Units.

Notes:
Step 1: Percent wetland loss/gain OR stressor length/area of shoreline length/total aquatic area
Step 2: Multiply Step 1 by normalized rank sum (row 3) to get impairment value
Step 3: Sum all impairment values for each action
Step 4: Increase by positive scaling constant value, 7.462, to get positive scores
Step 5: Multiply by 0.0935 to get on a scale of 0-10.

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4.4 Summary of Equation Components

Table 10 summarizes the ranges and scales of analysis for each of the equation components. Table 11 summarizes which components address each management measure.

Table 10. Summary of Scoring Range and Scales of Analysis for Each Equation Component

Component		Indices	Scoring Range	Scale of Analysis			
				Action Area	Site (process unit)	Sub-basin	Sound-wide
Quantity		Area of Restored Process	0 to maximum size in acres	Area of restored process for an action	Sum of actions in site	Sum of actions in sub-basin	Sum of actions Sound-wide
Quality	Process	Process Degradation	0 to 10	Action scale	Site scale	Overall calculation for all sites with actions	Overall calculation for all sites with actions
	Structure	Scarcity	0 to 1	n/a	Sub-basin scale	Sub-basin scale	Sound-wide scale
		Heterogeneity	0 to 1	n/a	Sub-basin scale	Sub-basin scale	Sound-wide scale
		Sinuosity	0 to 1	n/a	Site scale	Overall calculation for all sites with actions	Overall calculation for all sites with actions
		Longshore Connectivity	0 to 1	n/a	Site scale	Overall calculation for all actions in sub-basin	Overall calculation for all actions Sound-wide
		Cross-shore Connectivity	0 to 1	Action scale	Overall calculation for all actions in site	Overall calculation for all actions in sub-basin	Overall calculation for all actions Sound-wide
	Function	EFG&S Tier 2 Impairment [a]	0 to 10	Action scale	Site scale	Overall calculation for all sites with actions	Overall calculation for all sites with actions

Note:

a A modified EFG&S Impairment calculation is used that removes human-derived goods and services.

Table 11. Summary of which Management Measures are Addressed by Each Model Quality-Component

	PROCESS	STRUCTURE					FUNCTION	Summary: Is MM addressed by at least one index?
Management Measure	Degradation	Scarcity	Hetero-geneity	Sinuosity	Longshore Connectivity	Cross-shore Connectivity	EFG&S Tier 2	
1. Armor Removal or Modification	+	+[a]	+[b]	+	+		+	Yes
2. Beach Nourishment								No
3. Berm or Dike Removal or Modification	+	+[a]	+[b]	+	+		+	Yes
4. Channel Rehabilitation or Creation	+	+[a]	+[b]	+			+	Yes
5. Contaminant Removal								No
6. Debris Removal								No
7. Groin Removal or Modification					+			Yes
8. Habitat Protection and Policy Regulation	+[c]	+[c]					+[c]	Yes
9. Hydraulic Modification		+			+		+	Yes
10. Invasive Species control								No
11. Large Wood Placement								No
12. Overwater Structure Removal or Modification	+	+			+		+	Yes
13. Physical Exclusion								No
14. Pollution Control								No
15. Property Acquisition and Conservation	+[c]	+[c]					+[c]	Yes
16. Public Education and Involvement								No

Management Measure	PROCESS	STRUCTURE					FUNCTION	Summary: Is MM addressed by at least one index?
	Degradation	Scarcity	Hetero-geneity	Sinuosity	Longshore Connectivity	Cross-shore Connectivity	EFG&S Tier 2	
17. Revegetation								No
18. Species Habitat Enhancement								No
19. Reintroduction of Native Animals								No
20. Substrate Modification								No
21. Topography Restoration	+	+[a]	+	+	+		+	Yes

Notes:

a Model includes benefits of the management measure in situations where the management measure contributes to re-creating, restoring, or enhancing a scarce shoreform, or changes the length of shoreforms.

b Model includes benefits of the management measure in situations where the measure adds a shoreform.

c The benefits of habitat protection and property acquisition management measures on degradation, EFG&S Tier 2 impairment (modified), and scarcity index can be quantified. The benefits of these management measures are evaluated assuming that no additional stressors are constructed over the life of the project.

4.5 Benefits over Time

USACE policy requires that the benefits of a project be estimated over its period of analysis (typically 50 years), and on an annual average basis. Therefore, a project's expected benefits at intermittent points over 50 years are averaged to establish an annual average benefit factor. Process-based management measures may take several years before their ecological benefits to accrue. As discussed in section 5.1.1.1, enhancement measures could serve to "jump start" secondary ecological benefits (i.e., the habitat elements that will gradually be restored after processes begin operating again) during the early years of a project's life, while the process-based measures are still evolving and adjusting.

The maximum benefit (or 100 percent of the potential benefit calculated for a given action) is the raw ecosystem output (net) calculated for a particular action. For example, if an action's "With Project" ecosystem output is estimated to be 340 and its "Future Without Project" ecosystem output is estimated at 250, then the raw net ecosystem output is 90, which represents the maximum benefit (or 100 percent of the potential benefit). However, because this benefit of 90 is assumed not to be realized immediately, benefit trajectories were developed to estimate what portion of the calculated benefits will have accrued at any given point during the period of analysis.

Benefit-accrual curves (Figure 2 through Figure 6) to represent the accrual of ecological benefits over a 50-year period were developed with guidance from NST members. These curves are hypothetical trajectories of when benefits will accrue. Equations were developed from these curves (presented in the upper right corner of each figure). The curve-derived equations were used to generate data points, which can be used to calculate the annual average percentage of benefits, expressed as a percentage of the total calculated benefits (see Table 12). These benefit trajectories differ depending on what the primary restorative management measure is at a particular action, and whether additional restorative management measures and/or enhancement management measures are included as part of an action (see Table 13). The final ecosystem output score is the net benefit multiplied by the average annual benefit factor.

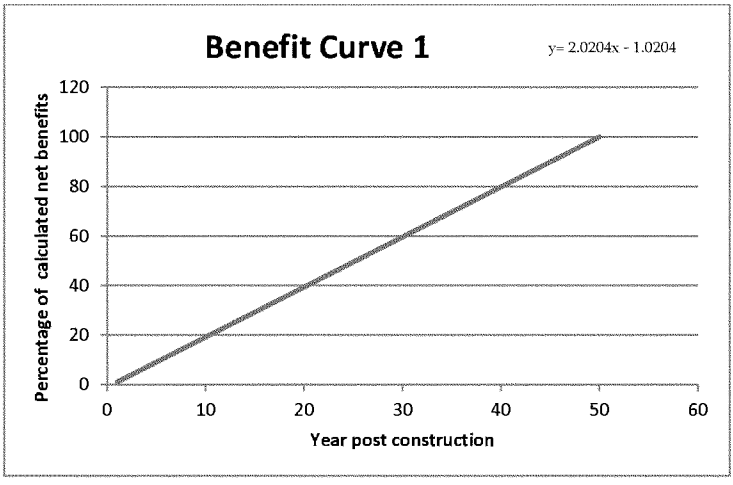

Figure 2.

Linear Benefit Curve: Benefits Accrue Steadily over 50-year Period

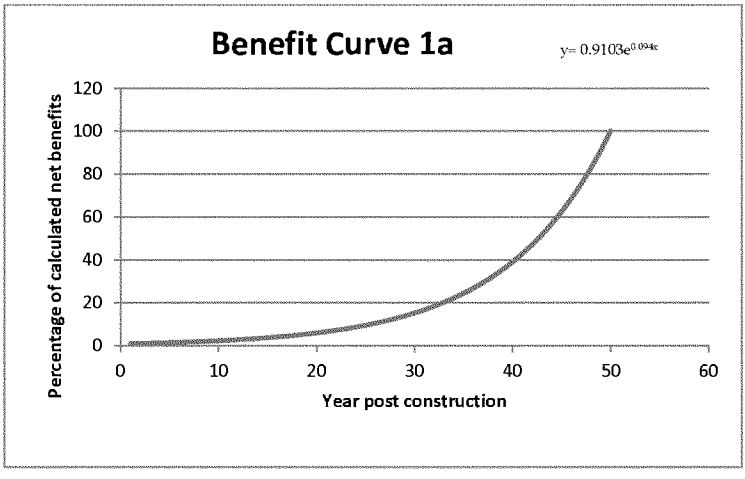

Figure 3.

Exponential Benefit Curve: Initially Benefits Accrue Slowly, Rate Increases toward End of 50-year Period

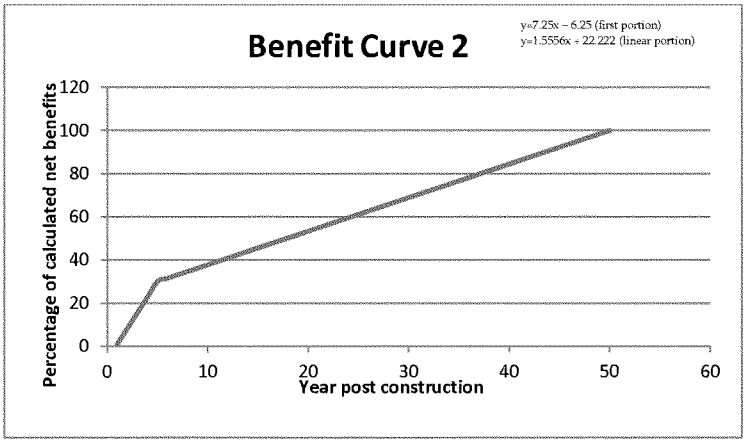

Figure 4.

Step Function Curve: Initial Spike in Benefits, but then Accrual at a Steady Rate over 50-year Period

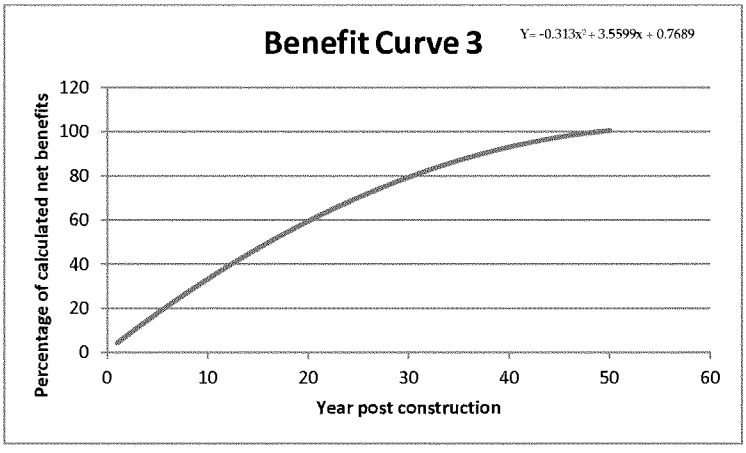

Figure 5.

Polynomial Curve: Benefits Accrue Steadily, but at a Faster Rate than Linear Curve over 50-year Period

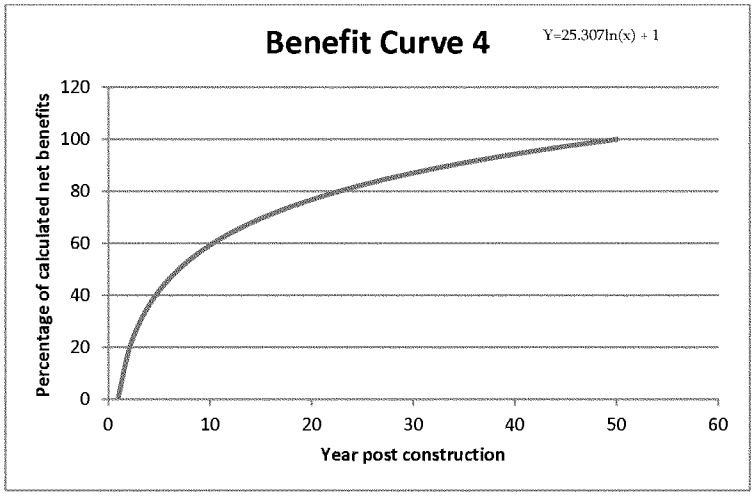

Figure 6.

Log Curve: Benefits Accrue Quickly Initially, then Level Off over 50-year Period

Table 12. Average Annual Benefits Factor for Each Benefits-Accrual Curve Type

Average Annual Benefit to Be Applied to Net Benefits	
Curve 1 – Linear	50%
Curve 1a – Exponential	22%
Curve 2 – Step Function	60%
Curve 3 – Polynomial	65%
Curve 4 – Log	76%

Table 13. Assignments of Benefit-Accrual Curves to Restorative Management Measures

Management Measure	Combination	Curve	Rationale for curve assignment
Armor Removal	Alone	1	Benefits acquired from armor removal will accrue progressively over time, with likely small fluctuations, as sediment from the feeder bluffs nourish the beach to their natural profile
	Plus enhancement measures (any number)	2	Enhancement measures such as beach nourishment and revegetation will increase the accrual rate of armor removal benefits over time
	Plus restorative measures (any number)	3	Restorative management measures such as berm/dike removal and groin removal will initially increase the rate of armor removal benefits over time (more so than enhancement measures)
Berm or Dike Removal or Modification	Full removal alone	3	Benefits acquired from a full berm/dike removal will accrue steadily but at a faster rate than linear since tidal inundation returns instantly and the establishment of low and high salt marsh is steadier.
	Full plus restorative measures (any number)	4	Restorative management measures such as armor removal and groin removal will increase the accrual rate of full berm/dike removal benefits over time (more so than enhancement measures)
	Partial alone	2	Benefits acquired from a partial berm/dike removal will accrue quickly in the first few years as natural tidal inundation is partially restored, but will transition to linear since tidal inundation is still constrained and still has altered tidal velocities.
	Partial plus restorative measures (any number)	3	Restorative management measures such as armor removal and groin removal will increase the accrual rate of partial berm/dike removal benefits over time (initially more so than enhancement measures)
Distributary Channel Creation or Rehabilitation	Alone	3	Benefits of distributary channel creation or rehabilitation will accrue quickly initially, due to immediate water flow; however, benefit accrual will transition to a linear pattern as tidal influence and sediment transport lead to channel migration and evolution.
	Plus enhancement measures (any number)	3	Enhancement management measures such as substrate modification and/or large woody debris placement will increase the accrual of benefits rate for distributary channel creation or rehabilitation as they mimic the results of natural processes.
	Plus restorative measures (any number)	4	Restorative management measures such as berm/dike removal and or armor removal will increase the accrual of benefits rate more quickly as natural processes return. The rate will decrease as channel migration and evolution slow.
Groin Removal	Alone	1	Benefits acquired from groin removal will accrue steadily over time as sediment from littoral drift nourishes the beach downdrift of the groin to its natural profile
	Plus enhancement measures (any number)	2	Enhancement measure such as beach nourishment and revegetation will increase the rate of groin removal benefits over time
	Plus restorative measures (any number)	3	Restorative management measures such as a berm/dike removal and armor removal will increase the accrual rate of groin removal benefits over time

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Management Measure	Combination	Curve	Rationale for curve assignment
Hydraulic Modification	Alone	2	Benefits acquired from hydraulic modification will accrue quickly in the first few years as tidal inundation and/or freshwater input is less constricted, but will transition to a steadier accrual as the establishment of marsh communities occurs.
	Plus enhancement measures (any number)	3	Enhancement measures such as placement of large woody debris and revegetation will increase the accrual rate of hydraulic modification benefits over time
	Plus restorative measures (any number)	4	Restorative management measures such as berm/dike removal and armor removal will increase the accrual rate of groin removal benefits over time (more so than enhancement measures)
Overwater Structure	Removal	4	Benefits of removing an overwater structure will accrue quickly as submerged vegetation reestablishes and fish migration along the shoreline improves. The benefit accrual rate will decrease as communities become established
	Modification	1	Benefits of modification of an overwater structure will accrue steadily as submerged vegetation and benthic communities partially reestablish, although shoreline migration may still be inhibited.
	Modification plus enhancement	2	Enhancement measures such as revegetation will increase the accrual rate of overwater structure modification initially, but after a few years, it will change to a linear accrual as benthic communities readjust toward equilibrium.
Topography Restoration	Alone	1	Benefits of topography restoration will initially accrue slowly as sediment shifts around and tidal inundation forms more localized topography. The accrual rate will increase more rapidly once vegetation and benthic communities are established.
	Plus enhancement measures (any number)	3	Enhancement management measures such as revegetation and substrate modification will increase the benefits accrual rate for topography restoration to a linear pattern.
	Plus restorative measures (any number)	2	Restorative management measures such as berm/dike removal and armor removal will increase the benefits accrual rate more instantly in the first few years and then transition to a linear pattern.

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The average annual benefits factor from Table 12 is assigned to each of the 36 proposed actions under PSNERP evaluation based on the curve that applies (detailed in Table 13). These percentages are applied to the net ecological benefits value, adjusting it to give an estimated ecosystem output value over a 50-year period. Actual timing of accrual of benefits could vary by different geographical areas, shoreform types, or process restored; however, these five benefits-accrual curves are applied generally to management measures regardless of geography, shoreform, or process. This adjusted value will be used in the benefits portion of the CE/ICA. The equation below details the process for applying these percentages:

Final EO = (EO "With Project" conditions – EO "Without Project" conditions)
* (Average annual benefit percentage)

The resulting time-weighted net benefits value for each proposed action is a score for that action that has no units associated with it. Changing the type or number of management measures applied at any given restoration action will change the resulting ecosystem output benefit score.

5 MODEL DEVELOPMENT WORK

The process of model design began with specifying the problem the model is needed to solve, and listing the objectives for the model. The purpose of the ecosystem output model is to support the CE/ICA that will comply with Corps planning policy, and to provide a decision-making tool for comparing potential restoration actions against each other.

5.1 Ecosystem Output Model Development Process

The Corps assembled an interdisciplinary team from within the broad group of PSNERP program participants; this team established the method for estimating ecosystem outputs likely to result from applying management measures at proposed restoration actions.

5.1.1 Development of Equation Components

The team selected and developed the individual metrics and indices that are the components of the quality portion of the ecosystem output model. These components represent process, structure, and function. As discussed in this report, an ecosystem output equation was developed for use in the model.

5.1.1.1 Consideration of Ancillary Benefits as an Equation Component

The team considered including Ancillary Benefits to account for the 13 management measures that would not directly restore process (Table 2). The term "ancillary" refers to management measures that do not directly restore nearshore processes, but rather enhance or "jump start" them by providing temporary on-site structure (a.k.a. habitat) while processes and functions recover enough to build natural structure on their own. Because these measures do not directly restore process, the ecosystem output component indices described above do not capture the ecological value of ancillary benefits. Therefore, the team chose initially developed an additional component that would quantify the benefits of these management measures, to evaluate how a particular management measure provides ancillary benefits to process and function. Through discussion at a workshop, the team decided that three variables would be included to characterize ancillary benefits. The three variables are 1) the proportion of processes benefiting from the enhancement management measure; 2) the proportion of EFG&S attributes affected; and 3) the area of the enhancement management measure. Eventually, the team decided to leave this component out of the equation because it did not influence the overall scores.

5.1.1.2 The Ecosystem Output Equation as First Proposed

The initial version of the equation used a different weighting of the components (as well as including the later-omitted ancillary benefits component), but was later revised so that the quality portion had more influence. The first equation proposed was the following:

$$EO = A * \left[P + S\ (.25 \text{ and } .10) + F\ (.25 \text{ and } .10) + E\ (.05 \text{ and } .02)\right]$$

Where: EO = ecosystem output

A = area of restored process

P = process degradation score, scale of 0 to 10

S = summation of landscape indices, scale of 0 to 10

F = EFG&S Tier 2 impairment, scale of 0 to 10

E = Ancillary benefits

In this equation, when ran on a suite of action, the area component accounted for 90 to 95% of the total score; in the final equation, area accounts for 75%.

5.1.1.3 The Quality Component of the Ecosystem Output Equation

The order of functions of the ecosystem output equation shows that process, structure, and function—which together make up the equation's quality component—are additive, that they combine to indicate the character of the physical location; therefore, the quantity component is multiplied by the quality component.

5.1.2 Testing of the Initial Ecosystem Output Equation

The team assessed the ecosystem output equation based on its ability to represent the measurement of ecological benefits for actions and alternatives. To test the equation, the model was applied to a selection of potential restoration actions, including actions from the PSNERP database that had previously been screened out or other comparable USACE projects. The results were analyzed to determine whether any of the parameters had a disproportionate effect on the EO scores.

This testing provided some insight on the sensitivity of the components' weighting. As a result, the "Ancillary Measures" index was removed from the equation when it was determined to have no meaningful effect on the scores.

The equation was tested further by calculating benefits for the suite of 36 actions that went forward to 10% design. A preliminary analysis of the calculated benefits indicated that the Area component was driving the outcome with excessive influence. Therefore, the final equation as presented in section 4.1 has been proposed to resolve this issue.

The final equation, as proposed in section 4.1 was tested to identify unwanted biases.

The team has used the final ecosystem output model to calculate ecological benefits of the final list of proposed actions that align with PSNERP strategies.

5.2 Ecosystem Output Model Documentation

This report documents the development process of the ecosystem output model for inclusion in the draft feasibility report, and provides the basis for peer review and model-approval analysis.

5.3 NST Review

The NST's involvement in the development of the ecosystem output model has been essential for a scientifically defensible product that is compatible with USACE policy. The following aspects of the ecosystem output model development process have had assistance, oversight, and review by the NST:

- Table 1, which specifies the area of restored process associated with each management measure
- Development and calculations of the individual components and their indices
- The order of functions for the complex of variable factors that comprise the ecosystem output equation
- How to estimate accrual of ecological benefits over time (discussed in Section 4.5)

5.4 Recognizing Uncertainty in Model Development

There are uncertainties that are inherent in the development of an ecosystem output model.

5.4.1 *Sensitivity Analysis*

The most common analytical technique used to explore the significance of uncertainty is a sensitivity analysis, which can be either qualitative or quantitative. Some project outcomes and decisions are sensitive to minor changes in assumptions and input values. Thorough, rational decision-making requires an explicit examination of such sensitivities.

Because the quantity component, expressed as area, seems to have a significant effect on the total output score, the team conducted a Spearman's Rank Correlation Test to determine whether the quality component of the equation affects the total output score. The test results show that the rank order of total scores is significantly different from the rank order of area among the 72 projects evaluated; therefore, the quality component does indeed have a significant contribution to the ranking of project by total score.

5.4.2 *Area*

The area of restored process, as defined in Table 1, can provide a useful way to incorporate an uncertainty element in the approximation of ecological benefits. The area of restored process could incorporate and present the uncertainty by creating polygons on a cost-effectiveness/incremental cost analysis frontier graph rather than points. Doing this provides some latitude to make decisions based on best professional judgment rather than adhering strictly to a single score (a point on the graph) that may seem more precise but which already incorporates some uncertainty. Assumptions could be made to characterize how far beyond the action area the benefit from the action reaches. The larger the distance, the more uncertainty there is.

5.5 Finalizing the Ecosystem Output Model

The team has finalized an ecosystem output equation. Results calculated with this equation reasonably estimate ecological benefits that make progress toward the planning objectives through a variety of restoration actions. The final benefits score has been calculated for proposed actions that will undergo CE/ICA. The team met in August 2011 for a final check on how the components are weighted and for discussion of any remaining issues.

5.6 USACE Model Certification/Approval Process

Any models used for planning and decision making in USACE projects must be either certified for repeated use or approved for one-time (i.e., single project) use by USACE

Headquarters (HQ). For certification, the Ecosystem Planning Center of Expertise (ECO-PCX) assembles a team to review the model, and the team may recommend that USACE HQ certify the model. Team members include experts from the Institute for Water resources (IWR), Hydraulic Engineering Center (HEC), Engineer Research and Development Center (ERDC), and other USACE field experts as appropriate (USACE 2007). Once ECO-PCX and USACE HQ certify a model, then any USACE project can use that model for planning and development. Model certification can take a significant amount of time and money to accomplish. For approval of this model for use in a single project, the model will be reviewed by an independent party and recommended for approval to USACE HQ. Approval for PSNERP-only use is the preferred route for this ecosystem output model.

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APPENDIX A
ECOSYSTEM OUTPUT EQUATION ALGORITHM

The following is the primary equation of the ecosystem output model including the formulas for its component metrics and indices:

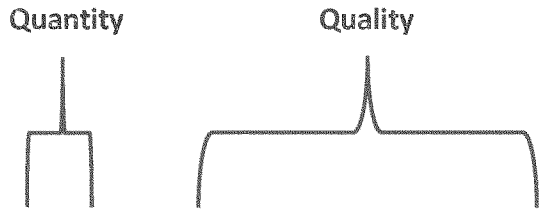
Equation:

Ecosystem Output = Quantity * Quality

Where:

Quantity = Area, in acres

Quality = Combined process, structure, and function components



$EO = A * [(P^2 + S + F)/\text{maximum possible score}]$

Where:

EO = ecosystem output

A = area of restored process

P = process degradation score, scale of 0-10

S = summation of landscape indices, scale of 0-10

F = EFG&S Tier 2 impairment (modified), scale of 0-10

Max possible score: 120

Components:

Process

P = Process

Where

Process = Process Degradation

Structure

S = Structure

Where:

S = 2 (Sc + H + Lc + Cc + Sn)

Such that:

Sc = scarcity

H = heterogeneity

Lc = longshore connectivity

Cc = cross-shore connectivity

Sn = sinuosity

Function

F = Function

Where:

Function= Tier 2 EFG&S Impairment (modified)

Indices:

Process Index

P = Process Degradation,

$$\text{Processs degradation} = \sum_{i=1}^{10}(1 - D)$$

Where:

D = the degradation of each process

While: $1 - D\begin{Bmatrix}10\\0\end{Bmatrix}$: 0 = fully degraded, and 10 = not degraded

Structure Indices

Sc = Scarcity Index

Scarcity Index = [|(C-H)/H|] * [1-(H/T)]

Where:

C = current occurrence of a shoreform by count within a basin, current wetland zone by area within a basin

H = historic occurrence a of shoreform by count within a basin, historic wetland zone by area within a basin

T = total count of all historic shoreforms within a basin, total wetland historic wetland area within a basin

While: $\text{Sc}\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = low scarcity shoreform, and 1 = highly scarce shoreform

H = Heterogeneity

Heterogeneity = $-\sum_{i=1}^{Sh}(pi \ln pi)$

Where:

Sh = the number of shoreforms in a sub-basin

p_i = the proportion of each shoreform (by length) in a

sub-basin (shoreform length/ total shoreline length).

While: $H\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 =no heterogeneity, and 1 = high heterogeneity

Sn= Sinuosity

$$\text{Sinuosity} = \frac{[(HisL_{PU} / HisSL_{PU}) - (\text{Min } (HisL/HisSL)_{SB})]}{[\text{Max } (HisL_{pu}/HisSL_{pu})_{SB} - \text{Min } (HisL_{pu}/HisSL_{pu})_{SB}]}$$

Where:

$HisL_{PU}$= Historic length of the process unit a candidate action is in

$HisSL_{PU}$ = Historic straight-line length of the process unit a candidate action is in

Min $(HisL_{pu}/HisSL_{pu})_{SB}$ = The process unit with the minimum ratio of historic length to shortest length among PUs in the sub-basin the candidate action is in

Max $(HisL_{pu}/HisSL_{pu})_{SB}$ = The process unit with the maximum ratio of historic length to shortest length among PUs in the sub-basin the candidate action is in

While: $Sn\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = lowest sinuosity PU in a sub-basin and 1 = highest sinuosity PU in a sub-basin

C_{LS} - Longshore Connectivity

$$\text{Longshore connectivity} = \frac{2(1-D)}{\text{Max } \{(1-D_L), (1-D_R)\} + P_{pot}}$$

Where:

(1-D) = degradation score of the process unit the action is located in

Max $\{(1-D_L), (1-D_R)\}$ = the higher of the adjacent (left and right) process units' degradation scores

P_{pot} = the maximum potential degradation score

While: $CLS\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = degradation score of action highly dissimilar from adjacent process units, and adjacent process units values are much lower than the degradation score of the process unit the action is in;

1 = degradation scores same as adjacent process units and adjacent process units degradation score is high.

C_{cs} = Cross-shore Connectivity

Cross-shore connectivity = the percent of undeveloped land that borders the landward portion of an action boundary

While: $Ccs\begin{Bmatrix}1\\0\end{Bmatrix}$: 0 = no undeveloped lands bordering the action; and 1 = all undeveloped lands border the action

Function Index

F = Function

$$\text{Function} = \sum_{j=1}^{13}(1 - I)$$

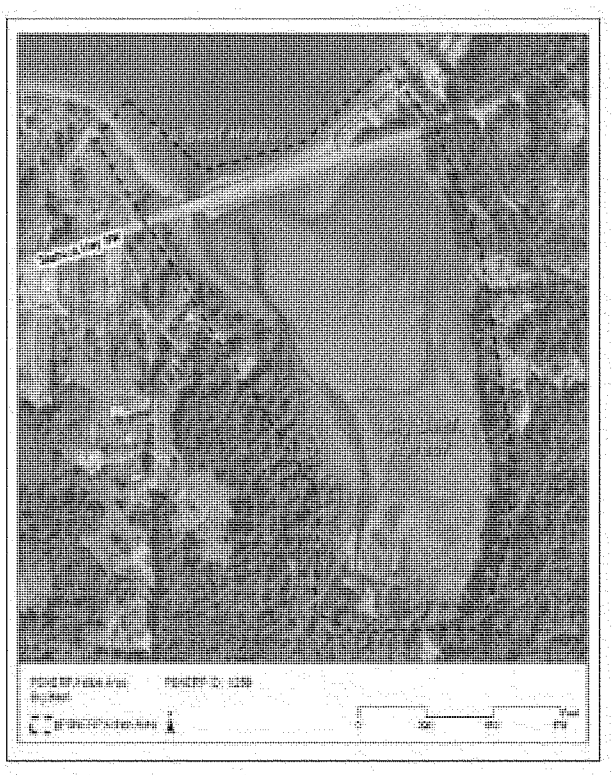
Where:

I= Tier 2 EFG&S Impairment (modified) scores for supporting and regulating categories

While: $1 - I\begin{Bmatrix}10\\0\end{Bmatrix}$: 0 = impaired , and 10 = not impaired

APPENDIX B
EXAMPLE CALCULATION BASED ON 10% CONCEPTUAL DESIGN

The equation, as presented in Appendix A, was tested on 36 actions that were advanced to 10% design. One project, Big Beef Creek Estuary Restoration, is presented here to show how the Puget Sound Nearshore Ecosystem Output Model can be applied to a proposed restoration action to calculate the average annual benefits.



- Action type: barrier estuary restoration

- Primary management measure: berm/dike removal

- Benefit accrual curve: #4 (65%)

- Area of restored process: 29.59 acres

Figure B-1. Big Beef Creek proposed estuary restoration area

Table 14 Calculations of model components for Big Beef Creek estuary restoration

.

	With Project	Without Project
Area	29.59	29.59
Process	7.66	3.63
Structure	5.05	1.62
Scarcity	0.22	0
Sinuosity	0.08	0
Heterogeneity	0.81	0.81
Longshore Connectivity	0.54	0
Cross-shore Connectivity	0.87	0
Function	7.16	6.67

With Project Conditions Benefit Calculation $A*(P^2+S+F)/120$

$29.59 * (7.66^2 + 5.05 + 7.16)/120 = 17.48$

Without Project Conditions Benefit Calculation

$29.59 * (3.63^2 + 1.62 + 6.67)/120 = 5.29$

Net Benefit (With – Without)

$17.48 - 5.29 = 12.19$

Time-weighting applied to calculate Average Annual Benefit

$12.19 * 0.65 = \mathbf{7.92}$

APPENDIX C
EO CALCULATIONS FOR 36 ACTIONS EVALUATED FOR CE/ICA

Table 15. EO Scores for Sites Evaluated for CE/ICA

Site	Alternative	Average Annual Net Benefits[2]
Beaconsfield Feeder Bluff	Full	2.18
Beaconsfield Feeder Bluff	Partial	1.32
Big Beef Creek Estuary	Full	7.89
Big Quilcene River Delta	Partial	0.56
Chambers Bay Estuary	Full	8.47
Chambers Bay Estuary	Partial	3.44
Deepwater Slough	Partial	90.21
Deer Harbor Estuary	Full	4.76
Deschutes River Estuary	Full	107.30
Deschutes River Estuary	Partial	90.39
Duckabush Estuary	Full	12.74
Duckabush Estuary	Partial	12.20
Dugualla Bay	Partial	162.58
Everett Marshland	Full	349.31
Everett Marshland	Partial	167.82
Hamma Hamma Estuary	Partial	10.59
Harper Estuary	Full	1.67
Harper Estuary	Partial	1.05
Lilliwaup Estuary	Partial	1.08
Livingston Bay	Full	41.59
Livingston Bay	Partial	40.47
Milltown Island	Partial	63.97
Nooksack River Estuary	Partial	166.32
North Fork Skagit Levee River Delta	Full	53.69
Point Whitney Lagoon	Full	1.95
Sequalitchew Creek Estuary	Full	0.91
Smith Island	Partial	191.51
Snow Creek and Salmon Creek Estuary	Partial	6.83
Spencer Island	Partial	136.01
Tahuya Estuary	Full	7.58
Telegraph Slough	Full	253.94
Telegraph Slough	Partial	16.30
Twin Rivers	Partial	0.15
Washington Harbor	Partial	0.58
WDNR Budd Inlet Beach	Full	1.14

[2] Intermediate scores, as shown for the example in appendix B, for all 36 of these sites are contained within an excel workbook. They are available upon request.

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX H

PUBLIC REVIEW COMMENTS

Integrated Feasibility Report and Environmental Impact Statement

US Army Corps of Engineers
Seattle District

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1 Introduction

This document responds to comments received on the Puget Sound Nearshore Ecosystem Restoration Study (Project) Draft Feasibility Report and Environmental Impact Statement (DFR/EIS) by the U.S. Army Corps of Engineers (Corps). Comments were submitted verbally at the public meeting held in Burlington, Washington, on November 5, 2014. Comments were also received in writing through letters and electronic mail. A total of 65 comment submittals were received. All comments were received during the 90-day open public comment period of October 10, 2014 through January 8, 2015.

2 Environmental Review Process

On October 10, 2014, the Corps released the Draft Feasibility Report and Environmental Impact Statement for public review. A Notice of Availability for public review of the documents was filed in the Federal Register (EIS No. 20140298). Printed copies of the DFR/EIS were available for public review at local public libraries. Additionally, the documents were available for public review on the Corps' website:
http://www.nws.usace.army.mil/Missions/CivilWorks/ProgramsandProjects/Projects/PugetSoundNearshoreEcosystemRestoration.aspx

The public review and comment period on the DFR/EIS began on October 10, 2014, and closed on January 8, 2015. One public meeting was held to receive public comment on the DFR/EIS and Appendices in Burlington, Washington, on November 5, 2014.

3 Document Organization and List of Commenters

This document contains copies of comments received during the comment period followed by the Corps' responses to those comments. Each comment is numerically coded in the margin of the comment letter, based on the order of the comments presented in the letter. The comments and responses are presented as follows:

- Master Responses (Section 4)
- Comments received at the public meetings, with responses (Section 5)
- Comments by email with responses (Section 6)
- Comments by mail with responses (Section 7)

A total of 65 comment submittals were received on the Draft Feasibility Study and Environmental Impact Statement. Each comment submittal was given a comment identification code. 14 comments were provided verbally at the November 5, 2014 public meeting. These comment submittals are identified as PM1 to PM14. 38 comments were provided by email; these submittals are identified as E1 to E38. The remaining 13 comments were received by postal mail; these submittals are identified as M1 to M13. Each comment submittal is listed below in Table 1.

Table 1: Public Comment Submittals received on the Puget Sound Nearshore Ecosystem Restoration Study Draft Feasibility Report and Environmental Impact Statement

Comment Identification	Date on Letter/Email	Commenter	Organization/Affiliation
Comments received at the November 5, 2014 public meeting			
PM1	11/5/2014	Gary Brandstetter	Marshland Flood Control District (MFCD)
PM2	11/5/2014	John Roozen	Private Citizen
PM3	11/5/2014	Kurt Kazwar	Private Citizen
PM4	11/5/2014	Curt Kraemer	Private Citizen
PM5	11/5/2014	Ed Stauffer	Private Citizen
PM6	11/5/2014	Peter Landry	Private Citizen
PM7	11/5/2014	Ann Bylin	Snohomish County Public Works
PM8	11/5/2014	Rone Brewer	Private Citizen
PM9	11/5/2014	Art Kendall	Private Citizen
PM10	11/5/2014	Ed Moats	Private Citizen
PM11	11/5/2014	Randy Good	Private Citizen
PM12	11/5/2014	Suzanne Phillips	Private Citizen
PM13	11/5/2014	Kathy Mitchell	Private Citizen
PM14	11/5/2014	John Roozen	Private Citizen
Comments received via email			
E1	10-10-2014	Kelly Turner	Private citizen
E2	10-10-2014	nathansuit@hotmail.com	Private citizen
E3	10-10-2014	Sarah Jackson	Private citizen
E4	10-11-2014	Kurt Zwar	Private citizen
E5	10-12-2014	Lorraine Karl	Private citizen
E6	10-13-2014	Terry Abrams	Private citizen
E7	10-20-2014	Forest Shomer	Inside Passage Seeds and Native Plant Services
E8	10-27-2014	Larry Helm	Private citizen
E9	11-3-2014	Doug Gresham	WA Department of Ecology
E10	11-5-2014	Gary Brandstetter	MFCD
E11	11-8-2014	Katherine Clark	Private citizen
E12	11-8-2014	Theodore Johnson	Private citizen

E13	11-8-2014	Robert Burrell	Private citizen
E14	11-8-2014	Jody Bogumil	Private citizen
E15	11-10-2014	Mary Cunningham	City of Everett Planning & Community Development
E16	11-10-2014	Sequoia Warner	Lowell Community Food Bank
E17	11-11-2014	Walter Kuciej	Private citizen
E18	11-11-2014	Larry Jensen	Private citizen
E19	11-11-2014	Larry Jensen	Private citizen
E20	11-12-2014	Scott Bedlington	Private citizen
E21	11-15-2014	Greg and Jennifer McKee	Private citizens
E22	11-20-2014	Jennie Sheridan	Private citizen
E23	11-20-2014	Ed Husmann	Snohomish County Farm Bureau
E24	11-21-2014	Michael Heath	Private citizen
E25	11-21-2014	Barbara Brenner	Whatcom County Councilmember
E26	11-21-2014	Dave Patterson	Private citizen
E27	11-21-2014	Edward Farrey	Private citizen
E28	11-21-2014	Henry Bierlink	Whatcomb Farm Friends
E29	11-23-2014	Joseph Kelly	Private Citizen
E30	11-24-2014	Tom Kearns	Private Citizen
E31	11-24-2014	Daniel Tepper	Whatcom Parks and Recreation Foundation
E32	11-24-2014	Justen Graham	Private Citizen
E33	11-24-2014	Robert Hughes	Private Citizen
E34	11-24-2014	Bob Norling	Private Citizen
E35	11-24-2014	Kelly Turner	Private Citizen
E36	11-24-2014	Pete Franett	Private Citizen
E37	12-2-2014	Suzanne Phillips	Private Citizen
E38	12-4-2014	Caroline Armon	OnBoard Tours Whales
Comments received via postal mail			
M1	10-18-2014	Kurt Zwar	Private citizen
M2	no date	Curt Young	Retired WDFW biologist
M3	11-18-2014	Allan Giffen	Everett Planning and Community Development
M4	11-19-2014	George Boggs	Whatcom Conservation District

M5	11-21-2014	Ann Russell	WRIA 1 Environmental Advocates Caucus
M6	11-21-2014	Roylene Rides-At-The-Door	Natural Resources Conservation Service
M7	11-21-2014	William Schmidt	Skagit County Farm Bureau
M8	11-21-2014	Peter Landry	Private Citizen
M9	11-21-2014	Brent Carson	Hadley-Colmenares family
M10	11-23-2014	Shari Tarantino	Orca Conservancy
M11	11-24-2014	Gary Brandstetter	MFCD
M12	11-24-2014	Alex Alexander	Private Citizen
M13	11-25-2014	Merle Jefferson	Lummi Indian Business Council
M14	1-6-2015	Scott Schuyler	Upper Skagit Indian Tribe

4 Master Responses

4.1 Master Response 1, Sites Removed from Tentatively Selected Plan

After the Tentatively Selected Plan (TSP) was initially identified, the Corps revisited the overall ecosystem restoration strategy for Puget Sound and developed a tiered implementation approach for 36 sites identified across Puget Sound. This tiered implementation master plan identifies various approaches for implementation of 36 projects: General Investigation (GI) projects to be recommended for construction, GI projects recommended for additional study, projects to be completed under existing Corps construction authorities (Continuing Authorities Program (CAP) or Puget Sound and Adjacent Waters Program (PSAW)), and projects to be completed by others.

Of the 36 sites identified for implementation across Puget Sound, three are being recommended for construction authorization under this existing Corps feasibility study and are presented as the recommended plan. The 3-site recommended plan is smaller than the 11-site TSP that was originally identified; however, the recommended plan is one aspect of the broader strategy to implement all 36 sites across Puget Sound.

Based on the strategic implementation master plan, the recommended plan and Agency Preferred Alternative and includes the following sites: Duckabush River Estuary, Nooksack River Delta, and North Fork Skagit River Delta.

- This master response applies to the following comments: PM1-1, PM3-1, PM4-2, PM5-1, PM6-1, PM7-1, PM8-1, PM9-1, E4-1, E10-1, E12-1, E15-1, E16-1, E24-1, E26-1, E27-1, E30-1, M1-1, M3-1, M8-1, M9-1, M11-2, M12-2, M14-1, M14-2

4.2 Master Response 2, Public Outreach

Public outreach and coordination is a key component of this restoration project. The Corps and local sponsors have worked to engage members of the public and other key stakeholders throughout the study, including multiple public meetings, listening sessions, and public review of the Draft Feasibility Report/Environmental Impact Statement. If Congress authorizes the recommended plan, targeted outreach will continue during the Preconstruction, Engineering, and Design Phase. During this phase, the Corps and local sponsors would continue to work to refine the project designs in coordination with landowners and stakeholders.

- This master response applies to the following comments: PM5-1, PM6-1, PM10-2, PM13-1, E23-1, M11-1, M14-1, M14-2.

4.3 Master Response 3, Loss of Farmland and Compensation for Real Estate

The Corps acknowledges and understands that many areas across the Puget Sound nearshore have long histories of agricultural production. The Corps also understands the value of agriculture in the Puget Sound region and recognizes that declining agricultural productivity is a significant concern. Proposed ecosystem restoration projects included in the recommended plan are intended to be compatible with ongoing farming and agricultural practices.

The Corps has initiated the process for compliance with the Farmland Protection Policy Act by providing the Farmland Conversion Impact Rating Forms to the Natural Resources Conservation Service for their review and input. When final project designs are available, the Corps will finalize the compliance process.

Information about Compensation:

Once the project footprint has been confirmed, the Corps Real Estate Division will identify the minimal real estate interest (fee purchase, easement, etc.) required for each affected parcel and develops a real estate map to reflect the real estate needs. Utilizing the real estate map that has been developed, an appraisal is performed on the property to determine its fair market value based on the type of real estate interest (fee purchase, easement, etc.) is identified for each respective parcel.

The determination for fee purchase versus easement is dependent on the amount of impact associated with the highest and best use of the property. For instance, if a pasture used for livestock was to be flooded on a frequent basis as a result of the project, and render the pasture unsuitable to raise livestock, that type of situation may constitute a fee purchase. Likewise, if only portions of a pasture were subject to flooding but the overall pasture remained suitable to raise livestock, that type of situation may constitute a flowage easement.

After the appraisal is complete, the sponsor will contact the respective landowners to make an offer on the property based on the appraised value. Once the selling price is set, the landowner conveys fee ownership or easement rights to the sponsor, which is recorded by the County assessor. Then, the landowner is paid. When easements are used instead of fee purchase, a deed restriction is placed on the property title, but the land remains privately owned after the project construction is complete. The easement protects the ecosystem restoration habitat improvement in perpetuity. Access to these privately owned lands is controlled by the landowner.

- This master response applies to the following comments: PM7-1, E8-1, E18-1, E19-1, E23-4, E25-1, E28-1, E37-1, M2-6, M4-1, M5-4.

5 Public Meeting Comments and Responses

5.1 Comments Received at the November 5, 2014 Public Meeting – Public Meeting Transcript

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

PUBLIC MEETING

U.S. ARMY CORPS OF ENGINEERS

SEATTLE DISTRICT

NOVEMBER 5, 2014

6:30 p.m.

Burlington City Hall

Council Chambers

833 South Spruce Street

Burlington, WA 98233

REPORTED BY: TERESA C. SMITH, CCR 3342

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GARY BRANDSTETTER

MR. BRANDSTETTER: Gary Brandstetter, B-R-A-N-D-S-T-E-T-T-E-R. I'm the secretary manager for the Marshland Flood Control District, and I have been asked by the commissioners to make a statement. We shall begin by saying we don't know whether we're for or against this project because despite your ten years or whatever it's been, we found out about it about two weeks ago because of a corps online e-mail, which if they could find us for that, I don't know why they couldn't find 6,200 acres in the last ten years to come and talk to us directly.

We are the second biggest of your projects, and I understand from the very nice lady, Nancy back there who I talked to when I came in, that the Nooksack people have been in direct contact with the corps and BFMW all this time. Well as far as I know, we don't have a single member. Certainly none of the commissioners -- I have been a legal counsel for the District for 20-plus years, and we've not had any direct contact. And that's a concern. And so we will be asking for an extension of the comment period. How do we find out more about this so we know whether we're for or against.

In addition to the fact that we're 6,200-plus acres, we are a governmental body, and when we found out about this, we contacted Snohomish County, and they didn't know

PM1-1

anything about it. I'm told that they were going to send somebody up here tonight. I don't know whether that's the case or not. We also have a member who went to an agricultural meeting on sustainable land strategies, and he mentioned the project, and the tribes didn't know anything about it.

So, I say this not to criticize the plan which we don't know and understand, but to criticize the process. And I'm getting the yellow signal and everybody wants to get out of here anyway, so I'll sit down. Thank you.

PM1-1

JOHN ROOZEN

MR. ROOZEN: My name is John Roozen, R-O-O-Z-E-N. I farm in Skagit County about 2,500 acres worth with my family in about 40 locations, and to even attempt to address this in three minutes is just unbelievable, so I will -- I will fail.

I just want to say that this is an unbelievably complex detailed system that started with a listing (ph), I'm thinking driven entirely by the listing (ph) of the salmon in the late '90s. That process should have driven a limiting factors analysis which somehow caused -- figured out what caused the species to go endangered.

PM2-1

Now, that starts out with a population dynamic study over time. The purpose of that is to overlay all the historical data, the biological data, the harvest data, the

natural events, the cultural events and everything, even the stuff that you have in the laws (ph). The whole presentation you're making is missing the population dynamics study over time. That was told to us in '96 and '97 by Dr. Carl Walters from the University of British Columbia, a brilliant man, one of the most brilliant in the world, and he said that's what you need first.

So if you go to the Federal Register in 1998 and 2000, you will see that this ESU number 8 in Puget Sound didn't have 100 percent habitat critical reason. It was a lot of anecdotal data and harvest data to see what the escapement and how this -- how the dynamics of this population worked. It was very poorly done.

I do believe that we live our lives forward. We analyze it in the rear-view mirror; that the Army Corps and WDFW should go back and do this population dynamics study over time. We have spent, in some people's minds, over $6 billion trying to save fish when we have no more fish.

So if you have that study, it's called Dynamics because it goes back and it will continue to improve as you get more data, and all the new projects, the $6 billion that has already been done will be in there; and the people that are out in the world that want to see a cost benefit analysis or a ratio of what their money is funding and what we're going to get for that, because we're not getting

PM2-1

anything yet, would then be able to see what this is going to do for us because it is -- it is wonderful to do some of the things you're doing, but when it comes to the conversion of farmland, I'm going to hope that that will be a brutal battle because for generational change, I might sell my farm for $10,000 an acre now. It used to be a lot less. I don't think so. In Whatcom County it's way more. But I'm selling it for a generation, okay; but when it's converted, if it stays in farming, it's going to be available to produce for a lifetime, and if it goes and is converted into habitat, it's also for a lifetime. At that point in time, I think that all farmland shouldn't even be considered for conversion unless it's started at 100,000 an acre. PM2-2

Like I say, I wish there was more time. I'll try and write a lot of my comments, but I'm hoping that these will be received very sincerely and we go back and we rebuild some of the foundation that might be missing.

(A train passed by.)

KURT KAZWAR

MR. KAZWAR: It's been a while since I have been in front of people. My name is Kurt Kazwar, K-A-Z-W-A-R, biology teacher for six years, Sumner High School, physical therapist for over 30 years. I'm retired. I have been doing a bunch of volunteer work on the Skagit Big Island

Farm Unit for fish and wildlife since 2011.

I would challenge anybody who can put on hip waders to go down there and go through that area in the wetlands area, the pristine wetlands area that we are supposedly trying to save, and walk through there and take a look at the thousands of frogs and salamanders and turtles and every other thing that is down there and say that this is just a piece of dirt and we're going to blow the dike, that's fine. You're going to be killing thousands and thousands of animals down there, and I hope to God that people are going to take a look at this and decide this is not just a piece of dirt, that it's worth saving and not just blow this thing away. PM3-1

On a sidelight note, I hope that everybody also takes a look at what's happening in the Okanogan Sockeye Run, which was just enormous 20 years ago. 2,000 fish, ESL, 400,000 this summer and going up. 400,000 fish. They can't believe it. It's off the charts. It's pre-1938. It's 100 years, kind of a record that they're going through there. And the chief guy who is the head of the nation, the alliance, the tribes above and below the border, said there's two things responsible. Water flow all connected across two countries, all these dams and habitat restoration in the headwaters, in the headwaters where they lay their eggs and the fish start. And if you blow that, PM3-2

you ain't going to get the kind of numbers you're seeing.

Remember, 2,000 to 400,000. We have to take a look at the headwaters, our headwaters, because if they say that it's in fine shape, it ain't because you are not getting fish coming down here. You can say what you want. I'll let somebody else who may be past on one minute or go more than me. Thank you.

PM3-2

CURT KRAEMER

MR. KRAEMER: Curt, C-U-R-T, Kraemer, K-R-A-E-M-E-R. My residence is in Marysville, retired fish biologist. I want to talk a little bit about salmon recovery in general. This is just one of the processes going on in the Pacific Northwest, in Puget Sound in particular. I really want to talk about when I look at these projects, one thing that jumped out immediately is on the Delta projects that are on public land, WFW land, restoration costs were about $25,000 an acre. When it moved to public lands, it was ten times that. $4 million per acre. That's pretty significant. Of course one of the reasons that the cost is so different is that you have to pay the landowners for the property, I mean, when you take public land from the WFW and other folks who weren't being paid for that land.

PM4-1

To date there have been a number of restoration projects that have occurred in the local region. Most of them -- all of them in this region occurred on public land.

Those projects resulted in significant loss of recreational opportunities for a wide variety of users. The agency, my understanding, has attempted to re-pledge (ph) those lands, have not been able to do that for lack of willing (inaudible) within the (inaudible) community and in Skagit County in general. I think it's blatantly unfair to continue to place the burden on salmon recovery on the public landowners, yet the private industry and the private agricultural communities, the Skagit County Government and the Snohomish County Government, are unwilling to participate and support replacement lands for those recreational units that have been displaced. Until such time, maybe we should place the burden on the private lands instead of the public lands. That's my first comment. I will write more detailed comments in my -- in my written presentation.

PM4-1

One other thing I was struck at when I looked at the projects proposed was the Feeder Bluffs situation in Puget Sound. We're all aware of that. That's a major driver in the foundation of the Ecosystem in Puget Sound. That's the return for bait fish and (inaudible) everything from orcas to Chinook salmon to bull trout to the various rock fish. Those are all key processes. There's only one of them projects that's addressed in that fashion. It's $4.4 million out of $1.1 billion. Less than one-half or 1

PM4-2

percent of the proposed budget is being directed towards this essential and very key proponent of -- keystone in the recovery of Puget Sound's Ecosystem. And your presentation was as an Ecosystem approach, we need to look at the foundations of the Ecosystem. If you're really serious about Puget Sound in the large scale, I would look there. Thank you. PM4-2

ED STAUFFER

MR. STAUFFER: Ed Stauffer. S-T-A-U-F-F-E-R. I would ratify what Mr. Roozen had to say. I'm a resident of Skagit County, and I value the quality of life that attends to us because of our farming community. I hate to see these huge programs develop which become applied to us like a square peg in a round hole. So I hope you'll take into consideration that in Skagit County we do have an existing comprehensive plan between (inaudible) Management Act. It is the law of the land, and I'd like you to in particular read the rural element. I helped to write it so I know what's in that. I don't know what's in your proposal because I understand you have been working for 12 years, and I understand that you also contacted -- that's in your materials -- our local agency somehow involved in this to help develop your list of priority sites. PM5-1

I -- I don't see any opportunity that I or any of us that live on the land and work with the land, had any part

in that process of site selection until now; and I don't know if we really have an opportunity to be involved in that now. I'd like to know what are the Skagit County sites that didn't make the 543 that are still slated for future screwing around with. I'm sorry. I shouldn't use terms like that. I say screwing around because I'm very concerned about terminology.

PM5-1

Now, you call this your Puget Sound project. You need to take into consideration that the research that you're doing to develop these concepts that you've presented for us tonight that will evolve in the plans with data later with more public money, supposedly, Puget Sound doesn't even apply to the waters off of Skagit County. That's a whole different system. I'm a classically trained biological scientist. I don't know from my training what an Ecosystem is, and I can't find a reference for that term before 1970.

PM5-2

If you're going to roll off your lips, "Ecosystem," after 12 years of study of our lands, then please give us a definition of what you're talking about. An Ecosystem could be anything. Once again, Mr. Roozen said, go back in time. Go back in time to where the ecology of the Puget Sound waters and the waters of the north out of the glacier (ph) river system were first impacted by the humans at the end of the glacier (inaudible) period. And our shorelines

in Skagit County were over 100 feet below what they are today. Now that's a dynamic system, and you have to take those kinds of things into consideration. So I hope you'll do that. PM5-2

Excuse me. I have to look at my quick notes here. Is my time up? My final brief comment is I watched President Obama for an hour and a half this afternoon describing what he planned to do with his agenda for the coming years. He's got two years left in his administration. And I, in essence, say he's going to be abandoning his EPA projects and going instead for putting money into building jobs and recreating wealth in the middle class. PM5-3

So you people that are working for these agencies and depend on the taxpayers' money, stop and think that under our system of government, your funding could dry up within two weeks. I hope it does. Thank you.

PETER LANDRY

MR. LANDRY: (Approached the podium playing the harmonica.) The Green Valley. That's a song written by a folk singer, and back in a time when we had freedom of speech, people paid attention to the writings of people a little bit more. Anyway, he -- I think he was trying to say as an environmentalist of the 1920s, when Gunthrie was saying that "This land was made for you and me," and that PM6-1

means me as a farm owner, that while I own the land, it's -- it's a balance. I don't own the land, but you own the land; and you own the land, and I own the land. And that as the other speakers very nicely spoke, that, you know, you have to pay attention to the people that live there before you come up with a plan and start saying, this is what we think ought to happen. And that ought -- that idea ought to be both thought of beforehand, given lots of opportunity for discussion, and be based on very, very good information that was come up with with no ulterior motives and things.

So, the bottom line is my name's Pete Landry. I am a Washington long -- lifelong Washington assistant, I'm an engineer, and a licensed engineer in the state of Washington, a licensed geologist, an engineering geologist in the state of Washington. I was also in the Coast Guard for seven years as a pollution investigator. I also worked four years for the conservation district system, and also been a public works director for four years. And the only reason why I know about this project like the first gentleman from the Marshland Flood Control District is because I was a government agent person that was on an e-mail list, and my farm is involved in something where they didn't bother to communicate anything to the landowners. Only -- I've only got into it because I was a

PM6-1

public works director once.

Now, here's where I have some problems with this. No involvement in the -- no landowner involvement in the plan or even any public involvement, really. It's not comparable to a five-year old -- just a five-year old effort to some various lands which did go through a public process. It doesn't respect the community nor the well over 100 years of farming, will destroy the largest riparian force of the west bank of the lower Snohomish River, which is a wetland of material (inaudible) well over 100 feet of 4 to 5 feet in diameter (inaudible) back when the first Europeans came, you know.

PM6-1

Now, if you flood the area, they will topple over like jackstraws, and yeah, I'm sure there's habitat there. We don't know if there's (inaudible) there. Actually the habitat does exist there. It also will require between a third to a half of a billion, with a B, dollars ignorance (inaudible) because they (inaudible) 30 years ago designed (ph) the dikes. It was the last big project. It was very high-tech, spent untold thousands of dollars preparing this plan without talking to anybody where I would -- just one person that owns property from 4 feet of (inaudible) the to 45 at the bottom north end of the valley, you'd stop it just by saying, I'm never selling, okay. So your project is done in the marshland because I'm not selling. And

there's other people that aren't going to sell too, okay. And also, no discussion on the (inaudible) people in here. It is simply the stupidest idea I've ever seen. And it's also -- a marshland is a dozen miles up the Snohomish River. It's (inaudible) if this is -- if they're going to spend a third of the money on this project in Puget Sound, here's your Ecosystem restoration project, and they're 12 miles up the freaking Snohomish River in an area that doesn't receive salt water even for 100 years of global warming, then we're in trouble.

Also, it is -- for that $350 million they could take that and revamp everything. There's a million households in the state of Washington with electric heat. That's a million households. Half of those -- half of the electric household heat could be re-fabbed [sic] with new heat pumps, get rid of those old inefficient baseboard heaters. That would be longstanding benefits for the global environment. It would mean jobs for people. It would mean -- it would mean that poor people, rather than being thrown out of their homes by a project, would be benefitted. This project picks on the poor people. There's a dozen households at the end of marshlands that are just owned by regular folk and one or two big companies, and we're going to be expected to move out as a part of the process of this to make this happen.

PM6-1

This is the most outrageous thing I've ever had. And like I said, I was a scuba driver when I was 15. I've lived here my whole life. I was in the Coast Guard, I was a licensed engineer, I know what I'm saying. This is wasteful, wasteful. So much can be done with a half a billion-dollars, and they don't even know that their $350 million price tag is way too low. Thank you. My name is Peter Landry, P-E-T-E-R L-A-N-D-R-Y. PM6-1

ANN BYLIN

MS. BYLIN: My name is Ann Bylin, A-N-N B-Y-L-I-N. I'm speaking on behalf of Snohomish County today, public works. The County fully supports the goals of this project, and we're equally committed to implementing salmon recovery plans. The County also (inaudible) protecting farmlands, as well as fish and wildlife habitat. These duly mandates often put us in the middle of a lot of issues. PM7-1

The County has been very proactive in restoration over the last ten years, and we've implemented many large scale restoration projects. We've learned a lot of lessons with these projects, and the primary lesson being engaging the public very early on in the process.

As a result of the inside implemented project, the County has (inaudible) sustainable land strategies process which brings together stakeholders, including the agg

community, the environmental community, and the tribal community. The goal is to achieve (inaudible) net gains for agg and fish. This is a collaborative approach (inaudible) multi-benefit project. The marshland project was submitted prior to SOS being formulated, and we spent a lot of years in the last two years building trust and relationships.

Let's see. We're concerned that by identifying some of the projects in the study, that it has circumvented our processes and the stakeholder (inaudible) fish and wildlife and proponents to engage landowners and stakeholders in this process and to evaluate if these projects make sense in respect with our SOS process and the reef (inaudible) planning efforts. Thank you.

PM7-1

RONE BREWER

MR. BREWER: My name is Rone Brewer. First name R-O-N-E, second name, B-R-E-W-E-R. And I'm livid. It's really hard for me to contain what I really want to say here, and some of you out there have already taken the brunt of that. I'm not going to apologize, actually, because I've spent six years of my life going to work group meetings on the farm that I own of the Skagit Wildlife area and that was to give you half of the island for fish restoration. And then the Corps project 1135, we spent three-and-a-half million-dollars on a fish restoration

PM8-1

project giving you 200 acres of the 400 dike, roughly. There's 200 left. We went through a public process. We developed alternatives, ten of them, and we chose one through a public process. We spent the money. We did a fish restoration project. It's done. Take it off the darn list.

There are other projects on here. Milltown Island. The dike broke on Milltown Island in 1976. You got fish restoration on the Milltown Island in 1976. There was a beautiful channel in there. They have been monkeying around with Milltown Island spending taxpayer dollars blowing holes in the dikes for 20 years, and the channels on that island are shallower now than they used to be. There's less channel habitat in Milltown Island than there was 20 years ago when the dike broke. PM8-1

Spencer Island, the dikes broke there eight, ten years ago. It's already restored. Why are we spending money on places that are already flooded. I have been through this all with some of the people in this room. Most of you are too young to even know what went on ten years ago. You were in college or high school or grade school, for God sake. I have been through it. I'm done and I'm planning on scoring a path through the regional department of fish and wildlife. Bob, you have been warned, if you're still here, because we've already been

there.

ART KENDALL

MR. KENDALL: I guess I'm speaking for my wife this evening. My name is Art Kendall, A-R-T K-E-N-D-A-L-L, and that's -- formerly it's Dr. Arthur W. Kendall, Jr. I was a fishery biologist for the Nellow (ph) Fishery for my career so I know a little bit about fish and fish habitat or a life history of fish. In fact, I wrote the book on that. But I wanted to speak tonight actually following up on Rone's comments on the Deepwater Slough project in particular.

The sheet here says that this is phase 2 of a highly successful phase 1 site restoration. How do you define "highly successful"? Is there any peer-reviewed literature? Now, this -- again I go back with Rone to the late 1990s where we had all these discussions, came up with a plan, did the project, spent $300,000 for a bridge from one half of the island to the other that's going to go away now, and the rest of the money that went into that, what's "highly successful"? Is there any peer-reviewed literature that has said that that has done anything? I don't think we should move forward with additional restoration until we know whether what we've already done, what we've already spent the money on, what we've already taken land way from its previous uses for, is shown to be successful.

PM9-1

And I guess another point is that we look at this as just brown dirt. I mean, you know, it's -- it's an -- it has no value now, so we're going to give it some value as salmon habitat. It has tremendous value now. It's a park that's owned by the people of the state of Washington. We own it. We manage it. We bought it. We manage it for -- particularly for water foul habitat and water foul hunting. It has a lot of other uses also, and just to take that way from us citizens of Washington without giving us anything in return, if you're -- if you insist on doing this, include replacing the functions that exist there now for public access and for the habitat before you do the restoration work. Fund. Have funding in place and actually do the purchase of additional lands elsewhere, put it in place before you put the shovels to the ground on this area, or any area that is not just brown dirt. And those -- as I say, those costs should be included.

PM9-1

One other thing, and I -- I hesitate to bring this up to the Corps of Engineers, but the Skagit River flows -- it has a certain volume, a certain flow. It gets down here to the delta and it spreads out. You have a thing about, you know, kind of the area that that spreading out goes through, you have the volume. You still have the same flow. If you keep increasing the area, you decrease the flow and so then it silts in. It's so simple. This is

what Rone was talking about. Milltown Island, that's what we're seeing. All along the bay front, it's -- it's silting in. There's -- there's less depth in the channels. It's a lot harder to get around, and is that even taken into consideration when we, again, continue to increase the area that we're -- that we're flooding. Thank you very much. PM9-1

ED MOATS

MR. MOATS: Hi. My name is Ed Moats, M-O-A-T-S. They're asking for comment, and that's a good thing, but I presume they mean informed comment. An informed comment, of course, requires information. When I listen to the presentation and I look around the room at the posters and displays and look at the information that you can obtain from the back table, I see question marks. Exactly where are these 5,000 acres, who owns them now, how many are already in government ownership, what's their GMA designation, what's the SMA designation, what's the zoning, what's their actual use now, what's their use history, how much of it is agricultural land. I suppose darn near 100 percent, but I don't know that for a fact. What's the agricultural history and history of use of this land. All of this information plus much more that I haven't thought of yet and that's running through your minds, is necessary for informed consent. PM10-1

Our attorney Gary Brandstetter just told us that the Marshland Flood Control District hadn't even learned about this project until a few days ago and that he is informed Snohomish County had not learned of this project until a few days ago. There is a principle of law that is applicable in every state of the United States and applicable in the federal courts and the federal legal system as well.

This an principle of law is that a person is presumed to intend the natural and probable consequences of his acts. A person is presumed to intend the natural and probable consequences of his acts. So I ask now, here we are 19 days before the comment deadline when the information suddenly becomes available, what is the intention of the government in this timing of events. Is it not clear that the -- if the intension is a natural and probable consequence, is it not the natural and probable consequence that there is going to be damn little informed comments because there's no opportunity to gather the information. I'm sure the government will deny that, and if they are sincere in their denial, they will extend the comment period out at least 90 days. Considering they're not even going to ask congress for an appropriation until the fall of 2015, they can certainly extend the comment period for 90 days and extend this event for 60 days so

PM10-2

that we can have another public discussion opportunity 30 days before the extended 90-day comment period. That would be in order, and I suggest that that's what the government should now do is extend the comment period for 90 days. Thank you. PM10-2

RANDY GOOD

MR. GOOD: Randy Good, R-A-N-D-Y, G-O-O-D. I, too, want to support the comments presented by John Roozen and also by Ed Stauffer. My understanding is that the next process on this is for congressional approval. I suggest we all contact Congressman Rick Larsen and Congresswoman Delbene, and have them deny any more funding to any of these 11 projects they're proposing. I think the first thing we have to do is stop the money from going to it. Thanks. PM11-1

SUZANNE PHILLIPS

MS. PHILLIPS: Hi. My name is Suzanne Phillips, S-U-Z-A-N-N-E, P-H-I-L-L-I-P-S. I would just like to point out in this booklet that you have here on juvenile salmon, what you admit that you don't know, you don't know that Chinook salmon, how they use the habitats associated with the shoreline area. You don't know what are the linkages between habitat use and the population of the salmon, resulting population. You don't know how salmon move around in Puget Sound. There's a list of seven things here PM12-1

that you don't know. To spend $1.1 billion of taxpayer money when we don't even know the basic facts is a ridiculous thing to do, and I hope -- I -- I don't mind this thing going through eventually if you can prove to me that it's going to produce some salmon and all that, then -- then I could take a look at it, but third grade science told me you don't just assume that people know just because they're scientists. Thank you.

PM12-1

KATHY MITCHELL

MS. MITCHELL: Thank you. That's K-A-T-H-Y, M-I-T-C-H-E-L-L. I live in Bow. I wasn't going to say anything at all because I don't know much about the project. I had not heard about it until this afternoon and came down to see what kind of information would be given and allowed to go over and be able to digest. I'm also a classically trained scientist, started off in biology, got my degree in geology. Just like other people here, multi-careers and a bunch of education (inaudible) experience. I think most people, by the time they get to my age and older, realize and learn that it's best to have all the information and facts in hand that you can to make good decisions before you sign off on anything, regardless of what somebody tells you. And at this point, with the information that we have, with all due respect to the folks who presented it to us, we appreciate that, but it's so

PM13-1

vague. There's so little information, there's no way anybody can really assess what's here. There's nobody that can endorse it that hasn't looked at it for ten years. And the public really needs to have more time to really see what's being proposed and to understand everything that's involved. It's a big price tag. If it is truly an important project, then you'll extend the public comment period to at least three months. That would at least allow people time to have their say (inaudible.) There is no way anyone can study that information.

Furthermore, I looked at all the information for the brochures for the people with the papers out there for the individual projects, and I do understand the time that they spent on them. I know that there's one and probably more that has (inaudible) a marketing glossy than actual science. So I would expect and require and ask that if our government dollars that are being spent on a project that is truly important and truly going to make a difference, that you give people time to study and to learn and to be properly informed before anything goes further; otherwise, it's completely (inaudible.) Thank you.

PM13-1

JOHN ROOZEN

MR. ROOZEN: John Roozen, R-O-O-Z-E-N, and I'm really thankful that I get to do this twice because I didn't finish. The -- the issue that is foundational to

PM14-1

the whole concept is why are we doing this. Because here's a little book that I found, which was in the back, for Skagit County, Mayor Fred Martin from LaConner, Jay Jax, President of New England Fish Company, Pacific Coast Maritime Council (inaudible), Olympic Fish and Game Protective Association, and (inaudible).

Okay. So that population dynamic study overtime that I talked about should be fundamental for every endangered species declaration. So you overlay events. The event here was 1937. The Army Corps built -- before that there was a jetty from Goat Island to McGlinn. That was taken out. It was a sheet pile one with logs. That was taken out by the WT Preston, the steamboat, and another one, a rock one was put in in 1937 to McGlinn Island by LaConner to divert the Skagit River silt. In 1993 a clinical study said 10 million tons a year -- that's why it's filing in over there on the island -- 10 million tons a year average comes down the Skagit River. (Inaudible).

So what I'm going to say here and read to you is, "It would overlay this if there was a drop." I'm going to read to you that "It is estimated by all salmon buyers that over half a million pounds of salmon annually are harvested from the waters of the Swinomish channel. Another half a million pounds is caught in the Skagit River mouth, and Inside Deception Pass, a million pounds of salmon

PM14-1

annually." They disappeared after this jetty was done. That's a manmade thing that would show in the study. All these things would show why they're happening. What else would show right now is the gentleman talked about all the Sockeye (inaudible) in Washington. We had a huge Sockeye Run predicted here and it didn't materialize because 50 percent of them were caught and the rest didn't show up so they didn't go up there. It's happening to the Cohos right now. The job of the river -- and we have a minimum industry flow, we just don't have any fish in the flow -- all living systems want to survive one (inaudible), and we're just not sending enough fish up there to make love and have babies and come back. PM14-1

We have the estuary. We have the biggest estuary in the Western United States. But I have been out that way. (Inaudible.) I got four boys, they're tough guys, and we've been out there in the height of the smelt season. And if the estuary is a limiting factor, it should be full, just like hotels are full or seats at the casino are full; but you go out there in the height of the smelt season and there's no smelt, because we're not letting them go up there. And harvest has not even been discussed. Population dynamics from the 1800s all the way through these projects, so Fisher Slough is in there, and it would show you how many that million-dollars is doing.

Every project has to pay its way and has to show to the taxpayers. Thank you very much. PM14-1

(The public comment section concluded at 7:18 p.m.)

REPORTER'S CERTIFICATE

I, TERESA CULP SMITH, a Certified Shorthand Reporter of the State of Washington, duly authorized to administer oaths, do hereby certify:

That the foregoing public hearing was transcribed by me, via machine shorthand, which was thereafter transcribed under my direction; that the foregoing transcript is a true record of the audio recording given, to the absolute best of my ability.

I further certify that I am neither financially interested in the action nor a relative or employee of any attorney or party to this action.

IN WITNESS WHEREOF, I have this date subscribed my name.

Dated: November 18, 2014.

_____

TERESA CULP SMITH, CCR 3342

5.2 Responses to Public Meeting Comments

5.2.1 Response to Public Comment PM-1

PM1-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the Marshland Flood Control District, City of Everett, landowners, and other key stakeholders will be notified to ensure closer coordination in the future.

5.2.2 Responses to Public Comment PM-2

PM2-1: Analysis of the complex Puget Sound nearshore system was based on the scientific guidance provided by the Nearshore Study's interdisciplinary team of scientists. The Nearshore Science Team has overseen the delivery of a series of peer-reviewed technical reports that provide the foundation of the Nearshore Study. These analyses led to identification of a problem of national significance, and to planning objectives necessary to address identified issues. The results of the Nearshore Study are based on a comprehensive analysis of historical and current conditions in the Puget Sound nearshore zone. Technical reports characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed through restoration. The Change Analysis "is a comprehensive, spatially-explicit assessment of the extent of change over Puget Sound's shorelines, estuaries, and deltas". The Change Analysis quantified structural and physical change between historical (1850s to 1890s) and current (2000 to 2006) conditions. Building on the results of Change Analysis, the Strategic Needs Assessment developed a complementary evaluation tool to investigate the degree of degradation to nearshore ecosystem processes. Evaluation of the Change Analysis and Strategic Needs Assessment results led the Nearshore Science Team to identify six major changes to the physical characteristics of nearshore ecosystems of Puget Sound. These changes can be grouped into two broad categories: 1) significant direct changes to the nearshore ecosystems of Puget Sound; and 2) widespread and pervasive changes. These observations support a science-based problem statement, providing the basis for Nearshore Study planning objectives. This technical foundation assisted the study team in formulating and recommending ecosystem restoration projects across the Puget Sound nearshore.

PM2-2: See Master Response 3.

5.2.3 Responses to Public Comment PM-3

PM3-1: See Master Response 1. The Deepwater Slough project is not being recommended for construction authorization at this time. The Corps will continue to evaluate potential impacts to amphibians, reptiles, birds, and mammals if this site is carried forward in the future.

PM3-2: Comment noted.

5.2.4 Responses to Public Comment PM-4

PM4-1: Project sites require a mix of public, private, and tribal property interests. Proposed ecosystem restoration projects included in the recommended plan are intended to be compatible with ongoing farming and agricultural practices while still maintaining recreational opportunities for public users. Real estate interests will continue to be confirmed as project footprints are refined during the Pre-Construction, Engineering, and Design phase.

PM4-2: See Master Response 1. Under the tiered implementation approach, a greater number of feeder bluff restoration sites will be pursued.

5.2.5 Responses to Public Comment PM-5

PM5-1: See Master Response 1 and Master Response 2.

PM5-2: The focus of this study is the Puget Sound nearshore zone, the transitional zone between major ecosystem types: terrestrial, freshwater, and marine. Many of the important and unique characteristics of Puget Sound depend upon the nearshore zone, including its high biological productivity, complex food webs, diverse habitats, and large numbers of plants and animals that occupy these habitats (Kozloff 1973; Sound Science 2007). Conditions in Puget Sound provide the context for the nearshore zone issues addressed in this study. The Puget Sound Nearshore Study aims to address the continuing degradation of nearshore ecosystems through restoration of natural processes (e.g., sediment movement and tidal hydrodynamics) and restoration and/or re-creation of coastal wetlands and embayments.

PM5-3: Comment noted.

5.2.6 Response to Public Comment PM-6

PM6-1: See Master Response 1 and Master Response 2. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the Marshland Flood Control District, City of Everett, landowners, and other key stakeholders will be notified to ensure closer coordination in the future.

5.2.7 Response to Public Comment PM-7

PM7-1: See Master Response 1 and Master Response 3. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, Snohomish County and other key stakeholders will be notified to ensure closer coordination in the future.

5.2.8 Response to Public Comment PM-8

PM8-1: See Master Response 1. The Everett Marshland, Milltown Island, and Spencer Island projects are no longer included in the recommended plan. If and when any of these projects move forward with Corps involvement, key stakeholders will be notified to ensure closer coordination in the future.

5.2.9 Response to Public Comment PM-9

PM9-1: See Master Response 1. The Deepwater Slough project is no longer included in the recommended plan.

5.2.10 Responses to Public Comment PM-10

PM10-1: The Final Feasibility Report and Environmental Impact Statement includes project footprints for each of the three sites included in the recommended plan. The Final Real Estate Plan includes documentation for real estate interests that will be affected by the projects based on the current project footprints and conceptual designs. At this stage of project design, GMA and SMA designations have not yet been confirmed because project footprints are still being refined. The Corps has initiated the process for compliance with the Farmland Protection Policy Act by providing the Farmland Conversion Impact Rating Forms to the Natural Resources Conservation Service for their review and input. When final project designs are available, the Corps will finalize the compliance process.

PM10-2: See Master Response 2. The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days. The Final Feasibility Report and Environmental Statement will be released for another 30 day review.

5.2.11 Response to Public Comment PM-11

PM11-1: Comment noted.

5.2.12 Response to Public Comment PM-12

PM12-1: Analysis of the complex Puget Sound nearshore system was based on the scientific guidance provided by the Nearshore Study's interdisciplinary team of scientists. The Nearshore Science Team has overseen the delivery of a series of peer-reviewed technical reports that provide the foundation of the Nearshore Study. These analyses led to identification of a problem of national significance, and to planning objectives necessary to address identified issues. The results of the Nearshore Study are based on a comprehensive analysis of historical and current conditions in the Puget Sound nearshore zone. Technical reports characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed through restoration. The Change Analysis "is a comprehensive, spatially-explicit assessment of the extent of change over Puget Sound's shorelines, estuaries, and deltas". The Change Analysis quantified structural and physical change between historical (1850s to 1890s) and current (2000 to 2006) conditions. Building on the results of Change Analysis, the Strategic Needs Assessment developed a complementary evaluation tool to investigate the degree of degradation to nearshore ecosystem processes. Evaluation of the Change Analysis and Strategic Needs Assessment results led the Nearshore Science Team to identify six major changes to the physical characteristics of nearshore ecosystems of Puget Sound. These changes can be grouped into two broad categories: 1) significant direct changes to the nearshore ecosystems of Puget Sound; and 2) widespread and pervasive changes. These observations support a science-based problem statement, providing the basis for Nearshore Study planning objectives. This technical foundation assisted the study team in formulating and recommending ecosystem restoration projects across the Puget Sound nearshore.

5.2.13 Response to Public Comment PM-13

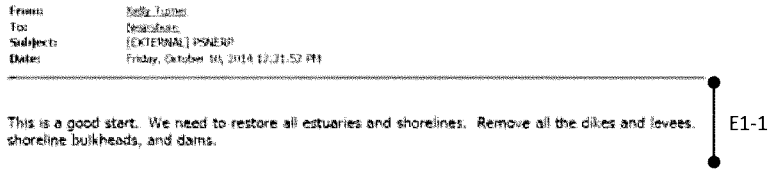
PM13-1: See Master Response 2. The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days. The Final Feasibility Report and Environmental Statement will be released for another 30 day review.

5.2.14 Response to Public Comment PM-14

PM14-1: Comment noted.

6 Individual Email Comments and Responses

6.1 Comment Letter E1 – Kelly Turner


From: Kelly Turner
To: Nearshore
Subject: [EXTERNAL] PSNERP
Date: Friday, October 10, 2014 12:21:52 PM

This is a good start. We need to restore all estuaries and shorelines. Remove all the dikes and levees, shoreline bulkheads, and dams.

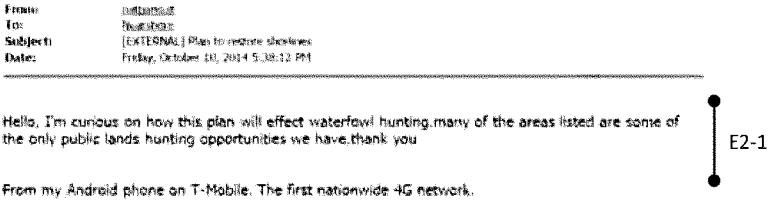
E1-1

Water Dragon

6.1.1 Response to Comment Letter E1—Kelly Turner

E1-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities to restore estuaries and shorelines.

6.2 Comment Letter E2 – nathansuit@hotmail.com


From: nathansuit
To: Nearshore
Subject: [EXTERNAL] Plan to restore shorelines
Date: Friday, October 10, 2014 5:38:12 PM

Hello, I'm curious on how this plan will effect waterfowl hunting.many of the areas listed are some of the only public lands hunting opportunities we have.thank you

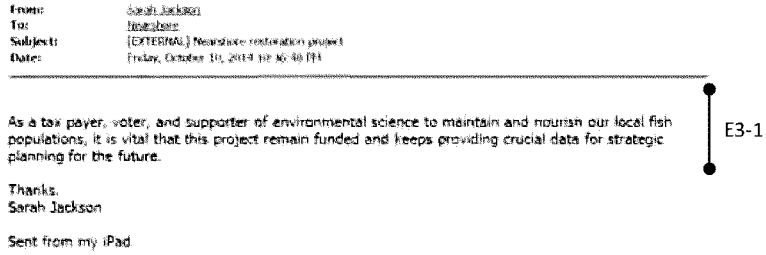
E2-1

From my Android phone on T-Mobile. The first nationwide 4G network.

6.2.1 Response to Comment Letter E2

E2-1: Section 5.4.2 of the Final Feasibility Report and Environmental Impact Statement discusses effects to waterfowl hunting. Waterfowl hunting opportunities may be displaced or substituted by new or different recreation opportunities e.g., bird watching. The recommended plan now includes restoration at three sites instead of 11, so fewer public hunting lands would be affected.

6.3 Comment Letter E3 – Sarah Jackson


From: Sarah Jackson
To: Nearshore
Subject: [EXTERNAL] Nearshore restoration project
Date: Friday, October 10, 2014 10:36:40 PM

As a tax payer, voter, and supporter of environmental science to maintain and nourish our local fish populations, it is vital that this project remain funded and keeps providing crucial data for strategic planning for the future.

E3-1

Thanks,
Sarah Jackson

Sent from my iPad

6.3.1 Response to Comment Letter E3

E3-1: Congressional authorization and appropriation are required prior to construction. Pending appropriation of funds, this project can continue to provide data and information for strategic planning for the future.

6.4 Comment Letter E4 – Kurt Zwar

From: maplest327@aol.com
To: Nearshore
Subject: [EXTERNAL] Deepwater Slough restoration project
Date: Saturday, October 11, 2014 1:53:02 PM

Dear sirs,

I volunteered with the WDFW several years ago to help restore the Big Skagit Island (Farmed section of the Skagit Wildlife Refuge). John Garrett was manager at the time of the Skagit Wildlife Refuge. The current manager, also knows me.

Along with beginning some restoration myself, I also spent time documenting the amphibian wildlife on the island. It is a 300 acre wildlife paradise with a very large population of native red legged frogs, salamanders and turtles. It is also home to beavers, otters, blacktailed deer, coyotes, small mammals and many, many bird species including nesting Bald Eagles.

I am very concerned that some people want to blow the dikes on the Big Skagit Island. If this is done....all of the extremely rare and valuable wildlife on this island will be destroyed. Nearly half of the island is freshwater wetlands. It is very beautiful there. No humans regularly go there except a few duck hunters in the fall.

I most respectfully recommend that any Deepwater Slough restoration project done will leave the dikes around the island intact and not destroy the existing wildlife on the island. Places like this are extremely rare....especially in western Washington.

For any of those who believe it should be done, I would hope that they would travel to this rare and beautiful island that is full of threatened and endangered native wildlife and check it out for themselves. These amphibians and other animals were native here before any humans arrived. Please let us not destroy a beautiful place that gives them a safe habitat.

Salmon are not the only species we need to protect. Even the animals we do not eat deserve our respect.
Frogs are often found on the totem poles of NW Indians. I hope we can still allow them to survive in the last places we have not conquered and turned into civilization.

Many thanks for listening.

Sincerely,

Kurt Zwar, PT
3954 NE 115th St.
Seattle, WA 98125
maplest327@aol.com
206 362-2477

BS Zoology, UW 1973

E4-1

6.4.1 Response to Comment Letter E4

E4-1: See Master Response 1. The Deepwater Slough project is not being recommended for construction authorization at this time.

6.5 Comment Letter E5 – Lorraine Karl

From: Lorraine Karl
To: Questions
Subject: [EXTERNAL] Restoration project
Date: Sunday, October 12, 2014 10:23:07 AM

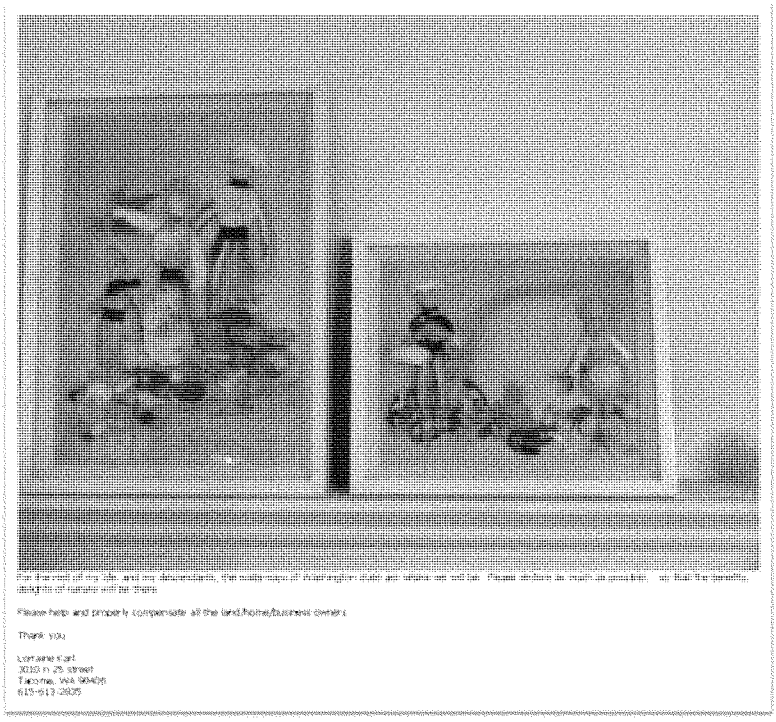
Go for it!! Do it still! I have watched wildlife disappear in just decades, development was allowed to expand to the point of no return for tidal wildlife. This was a different coast, a different state. The nature I loved, the tidal marsh is gone.....what you see in this photo is gone.
If I could have given up the family home to restore and clean the environment, I would gladly have done so. The real estate there has become too costly to allow restoration. Where it is still possible, please do as much as possible.



This photo is at the waters edge in front of Aunt Margies cottage.

I was privileged to grow up in a cottage on tidal wetlands of Weakley pond, originally fresh water. A channel to little peconic bay was dredged, a marina established. All the homes surrounding the pond, channel and little preconceptions bay were on cesspools/septic. The communities surrounding the bay were home passed generation to generation. When I was a little girl I could see the bottom of shallow areas of weakley pond, the channels, little peconic bay. I could go swiing at night with a lantern, seeing the eels easily. Blue claw crabs could be scooped with a net....I could see them. How many hours did I watch fish, horseshoe crabs, fish, scallops with iridescent eyes from a floating platform a hundred feet from shore in Little Peconic Bay.
It's all bulkheaded, docks, boats....and no more horseshoe crabs, clamming, scallops with beautiful eyes. As a child I gathered these shells for my Grandma Rose. she made this art from them. The shells are gone

E5-1

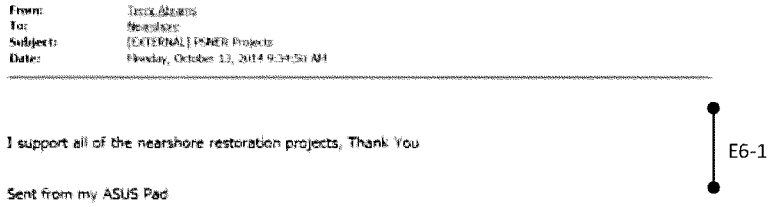


E5-1

6.5.1 Response to Comment Letter E5

E5-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore. The Corps is currently working to identify the lands needed for/affected by the project footprint. Once the project footprint has been determined, the Corps Real Estate Division identifies the minimal real estate interest (fee purchase, easement, etc.) required for each affected parcel and develops a real estate map to reflect the real estate needs. Compensation for lands, homes, and business owners will be based on this real estate evaluation.

6.6 Comment Letter E6 – Terry Abrams


From: Terry Abrams
To: Nearshore
Subject: [EXTERNAL] PSNER Projects
Date: Monday, October 13, 2014 9:34:50 AM

I support all of the nearshore restoration projects, Thank You

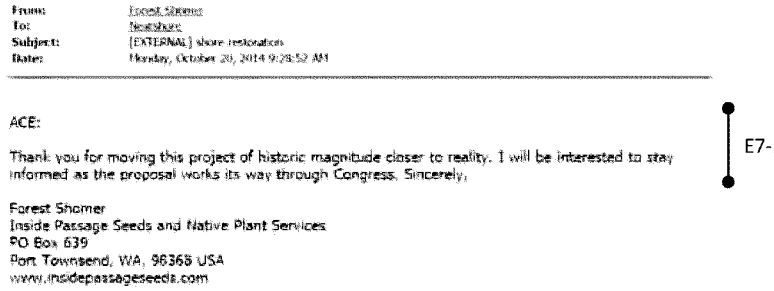
Sent from my ASUS Pad

E6-1

6.6.1 Response to Comment Letter E6

E6-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore.

6.7 Comment Letter E7 – Forest Shomer


From: Forest Shomer
To: Nearshore
Subject: [EXTERNAL] shore restoration
Date: Monday, October 20, 2014 9:28:52 AM

ACE:

Thank you for moving this project of historic magnitude closer to reality. I will be interested to stay informed as the proposal works its way through Congress. Sincerely,

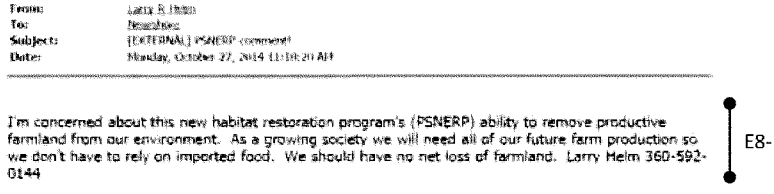
Forest Shomer
Inside Passage Seeds and Native Plant Services
PO Box 639
Port Townsend, WA, 98368 USA
www.insidepassageseeds.com

E7-1

6.7.1 Response to Comment Letter E7

E7-1: Thank you for your comment. Your name has been added to the project's distribution list to receive future updates.

6.8 Comment Letter E8 – Larry Helm


From: Larry R Helm
To: Nearshore
Subject: [EXTERNAL] PSNERP comment
Date: Monday, October 27, 2014 11:18:20 AM

I'm concerned about this new habitat restoration program's (PSNERP) ability to remove productive farmland from our environment. As a growing society we will need all of our future farm production so we don't have to rely on imported food. We should have no net loss of farmland. Larry Helm 360-592-0144

E8-1

6.8.1 Response to Comment Letter E8

E8-1: See Master Response 3.

6.9 Comment Letter E9 – Doug Gresham, Washington Department of Ecology

From: Gresham, Doug (ECY)
To: Nearshore
Subject: [EXTERNAL] PSNERP Public Comment
Date: Monday, November 03, 2014 3:00:49 PM

Attn: Ms. Nancy C. Gleason, U.S. Army Corps of Engineers

I wish to submit comments on the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) draft feasibility report and environmental impact statement. As the wetland specialist responsible for a portion of this area (San Juan, Skagit, and Snohomish Counties) I offer these comments on wetland regulation and water quality protection. I specifically reviewed 7 out of the 11 restoration sites listed in the tentatively selected plan that fall within my jurisdiction. This includes Deer Harbor Estuary in San Juan County; Telegraph Slough, North Fork Skagit River Delta, Deepwater Slough, and Milltown Island sites in Skagit County; and Spencer Island and Everett Marshland sites in Snohomish County.

In general, I support the restoration of these wetland habitats and their improvement in functions and values. These projects will restore valuable habitat that has been lost through dike construction and agricultural drainage practices. I support the thoughtful engineering approach of breaching short sections of levees, filling of drainage ditches, and excavating feeder channels to allow tidal currents to aid restoration. This approach will prevent large scale erosion of newly flooded areas, protect the infrastructure that remains, and minimize water quality impacts. E9-1

While Ecology supports the removal of levees, this work will require state and federal authorization. The wetlands on these sites are waters of the state subject to the applicable requirements of state law (see RCW 90.48 and WAC 173.201A) and Section 401 of the Clean Water Act (33 USC §1341) and 40 CFR Section 121.2. The wetlands on these sites are also shoreline-associated wetlands regulated under the state Shoreline Management Act (RCW 90.48) and County Shoreline Master Program. State authorization is required for work within waters of the state and any proposed impacts should be accurately identified in the environmental documentation and project drawings. The delineated wetland boundaries will need to be field-verified by Ecology or the U.S. Army Corps of Engineers (Corps) before ground disturbing activities begin. E9-2

We also have concerns with temporary construction impacts to water quality from the excavation and filling of these areas. A temporary erosion and sediment control plan should be implemented to minimize the release of sediment into waters of the state. In addition, best management practices such as timing restrictions, fish exclusion methods, and preparing a spill prevention and control countermeasures plan should be used to protect water quality. E9-3

Thanks again for the opportunity to comment on this restoration plan. Let me know if you have questions.

Doug Gresham, PWS
Washington State Department of Ecology
3190 - 160th Ave. SE
Bellevue, WA 98008
Phone: (425) 649-7199
Email: Doug.Gresham@ecy.wa.gov <mailto:Doug.Gresham@ecy.wa.gov>

6.9.1 Responses to Comment Letter E9

E9-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities to restore wetland habitats across the Puget Sound nearshore.

E9-2: Chapter 7 of the Final Feasibility Report and Environmental Impact Statement describes compliance with applicable laws and regulations, including Section 401 of the Clean Water Act. The Corps will continue to coordinate with Ecology as project designs are refined during the Pre-Construction, Engineering, and Design phase. Applicable requirements of state and Federal law will be met prior to construction.

E9-3: Section 5.7.1 of the Final Feasibility Report and Environmental Impact Statement describes standard practices to mitigate negative impacts of construction. Section 5.7.2 describes best management practices that will be implemented to project water quality.

6.10 Comment Letter E10 – Gary Brandstetter, Marshland Flood Control District

MARSHLAND FLOOD CONTROL DISTRICT

P.O. Box 85 • Snohomish, Washington 98291-0085 • Tele (360) 568-6044 • Fax (360) 568-3785
Sponsoring **MARSHLAND WATERSHED PROJECT**

November 5, 2014

To: U.S. Army Corps of Engineers and Washington State Department of Fish & Wildlife

Re: Proposed Everett Marshlands Project

Ladies and Gentlemen:

This letter is submitted on behalf of the Marshland Flood Control District (MFCD), a Special Purpose District formed and operating under RCW Chapter 86.09. MFCD is a governmental body whose three (3) Commissioners are elected in staggered six (6) year terms, one of which comes up for re-election every two (2) years. MFCD has statutory authorization to assess owners of property in the District to support its system of agricultural ditches, a flood canal and a pump station with two (2) 100 hp and four (4) 250 hp pumps. The system has been fully in place since the 1960's, and partially in place based on two (2) predecessor drainage districts since the early 1900's. This system, supported by assessments paid by approximately 100 landowners, drains over 6,200 acres of privately owned land, most of which is agricultural.

With this background, MFCD wishes to express its concern regarding the fact that there has been little, if any, notice of the joint Corps/DF&W proposal. There has also been a total lack of involvement with MFCD and its members. In short there has been a total failure to seek participation from MFCD.

E10-1

Every one of the 829 acres included in this joint Corps/DF&W proposal is located within MFCD boundaries and yet there has not been any direct contact with, or requested input from, the governmental body given statutory authority over all 829 acres proposed for removal from District services. Likewise, as far as MFCD is aware, not one property owner whose land is proposed for wetland/fish habitat restoration has been involved in planning this proposal.

These seem to MFCD to be serious defects in the process and MFCD does not make these assertions lightly. MFCD's Secretary/Manager received an email notice – out of the blue – on October 13, 2014, happenstantially the day of MFCD's monthly meeting. The notice listed "Everett Marshlands" as one of 11 projects proposed for wetland and fish habitat restoration. There was, however, no individual project information.

In a day or two, MFCD's federal sponsor, NRCS, contacted the District and forwarded information from an internet link that provided some specifics – the only specifics revealed to date. MFCD then contacted Snohomish County – one of whose major arterials is proposed for "removal" – and it had no notice. An MFCD member who meets with the Sustainable Land Strategies (SLS) committee mentioned the project at an SLS meeting and members of the Tribes knew nothing about the proposal.

It is true that, several years ago, the City of Everett adopted a mitigation plan for this area, which may have been a template of sorts for this proposal. But MFCD and its members made consistent

and repeated objections to Everett's proposals and were told, after public meetings and in private, that "This is not going to happen for 30 years or more, if at all. The City has no money to even study the feasibility. The City just needs to satisfy DOE's demands for mitigation because of development on Everett's Puget Sound waterfront." That waterfront is on the opposite side of town from their mitigation proposal, by the way.

Further, after adoption of the City plan, MFCD heard nothing else. The plan seemed to disappear. Last fall, MFCD received a call from someone at DF&W who requested that some visiting Army Corps "brass" be allowed to inspect MFCD's pump plant the following day. The notice was short and created a conflict, but MFCD had its pump plant operator present to open the gates. He was shown – but not given – a map which he reported proposed moving the pump plant a mile upstream. After the visit, however, nothing more was heard.

In summary, there has been little notice to, and absolutely no involvement of, MFCD or its members when MFCD is the governmental body given statutory authority over these 829 acres. Until and unless there is a totally transparent sharing of information and negotiation of specifics, MFCD has no choice but to object to the process. If the article in Tuesday's 11/4/14 HERALD is correct, that the MFCD property owners have to go along or the project is dead because eminent domain cannot be used, the Corps and DF&W have started off on the wrong foot.

Very Truly Yours,

Gary W. Brandstetter
MFCD Secretary/Manager and Legal Counsel

C: Don Bailey, Chairperson
Marv Thomas, Commissioner
Tim Stocker, Commissioner

6.10.1 Response to Comment Letter E10

E10-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer coordination in the future.

6.11 Comment Letter E11 – Katherine Clark

From: [redacted]
To: Nooksack
Subject: [EXTERNAL] Nooksack
Date: Saturday, November 08, 2014 9:13:39 AM

I think its a great idea to improve the habitat around the Nooksack Delta- I hope this project goes through. The Lummi Nation has an excellent Natural Resources department that has begun much of this work there as tribal members livelihood's depend upon successful salmon runs. Excellent news. E11-1

Katherine Clark
Leigh Wirth
Bellingham, Washington

Sent from Windows Mail

6.11.1 Response to Comment Letter E11

E11-1: Thank you for your comment. The Corps is carrying forward the restoration project at the Nooksack River Delta and continues to coordinate with the Lummi Nation as project designs are refined.

6.12 Comment Letter E12 – Ted Johnson

From: Ted Johnson
To: david.price@dfw.wa.gov
Cc: mcunningham@ci.everett.wa.us; pugetsoundnearshore@dfw.wa.gov; Nearshore
Subject: [EXTERNAL] Everett Marshland Property
Date: Saturday, November 08, 2014 11:48:59 AM

Mr. Price,
I recently learned about a plan to significantly change the Everett marshland of the Snohomish estuary as a part of the Puget Sound Nearshore Ecosystem Restoration Project.

I am a home owner in this area and according to the drawings provided at http://www.pugetsoundnearshore.org/factsheets/Everett_TSP.pdf it appears my property could be seriously impacted. I am deeply concerned both about the project and the fact that there was no direct communication with the community and notification to home owners about these plans. It was only because another homeowner in the area discovered the project and contacted the Everett Herald that I heard about it. The "outreach" at the same website is notable in the complete lack of communication to the Everett area. There are several CCs to this email, because I could not find any clear indication of where to send my comments. E12-1

In my mind the feasibility of a successful and sustainable project of this magnitude is highly questionable. Further, the many property owners should be given early and adequate notification and opportunity to understand the changes and impacts, as well as be able to give feedback and consent.

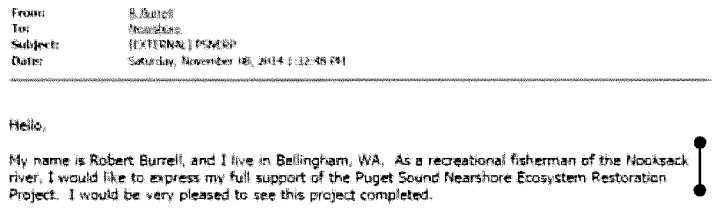
Without clear descriptions of how this project will affect use of my property during and after the project and future property value, I cannot give my support.

Sincerely,
Theodore Johnson
7725 Larimer Rd
Everett, WA

6.12.1 Response to Comment Letter E12

E12-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, you and other key stakeholders will be notified to ensure closer coordination in the future.

6.13 Comment Letter E13 – Robert Burrell



From: R Burrell
To: Nearshore
Subject: [EXTERNAL] PSNERP
Date: Saturday, November 08, 2014 1:32:48 PM

Hello,

My name is Robert Burrell, and I live in Bellingham, WA. As a recreational fisherman of the Nooksack river, I would like to express my full support of the Puget Sound Nearshore Ecosystem Restoration Project. I would be very pleased to see this project completed. E13-1

Thank you very much for your time.
Robert Burrell

6.13.1 Response to Comment Letter E13

E13-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore.

6.14 Comment Letter E14 – Jody Bogumil



From: Jody Bogumil
To: Nearshore
Subject: [EXTERNAL] protect our shoreline
Date: Saturday, November 08, 2014 7:00:23 PM

Hi,

I live in Bellingham and we need to do all that we can to protect this beautiful area. Please follow through will the program to restore our shoreline. Our shoreline has undergone massive pollution and destruction and if the coal port moves in, we are going to see things get worse and worse. Any and all help that we can offer would be greatly appreciated. E14-1

Thank you very much in advance.

Jody Bogumil

6.14.1 Response to Comment Letter E14

E14-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore.

6.15 Comment Letter E15 – Mary Cunningham, City of Everett

From: Mary Cunningham
To: "Ted Johnson"; david.price@dfw.wa.gov
Cc: puegetsoundnearshore@dfw.wa.gov; Nearshore
Subject: [EXTERNAL] RE: Everett Marshland Property
Date: Monday, November 10, 2014 11:21:04 AM
Attachments: PSNERP FAQs.pdf

Mr. Johnson,

Thank you for including me in your email.

As you may recall, in 2009 the City of Everett adopted the Marshland Subarea Plan that addressed restoration potential in the Marshland area. In that Plan the City committed to working with willing property owners, and to completing a large number of studies to ensure that any restoration proposed in the area was technically feasible and would not harm adjacent property owners who do not want to be included in a restoration project. It also made clear that property owners could change their willingness to participate over time, as this was a long-term planning process. The City continues to commit to meeting those requirements in our plan.

I'm attaching a document that answers frequently asked questions regarding the PSNERP process. As you can see in the highlighted text, PSNERP also commits to working with willing property owners, and to complete additional studies and designs for the projects. This is a 20-year plan and, if the Marshland restoration is included in the final plan, it may be many years before the project gets to the design and construction phases. E15-1

I understand that property owners are concerned that they did not receive notice during this part of the process. I will be mailing the frequently asked questions to all of the property owners in the area.

Please feel free to call or email me if you have any questions regarding potential future restoration in the area.

Mary Cunningham

City of Everett Planning & Community Development

2930 Wetmore Ste. 8A

Everett, WA 98201

425-257-7131

mcunningham@everettwa.gov <mailto:mcunningham@everettwa.gov>

6.15.1 Response to Comment Letter E15

E15-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the City of Everett, Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer coordination in the future.

6.16 Comment Letter E16 – Sequoia Warner

From: Sequoia Warner
To: Nearshore
Subject: [EXTERNAL] Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)
Date: Monday, November 10, 2014 1:26:44 PM

I am writing concerning Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Draft Feasibility Report and Environmental Impact Statement

Specifically: Everett Marshland, Everett, WA

Though I am all for restoring habitat, I believe for this particular project it will do more harm than questionable benefit. I garden at Red Barn Community Farm for the Lowell Community Food Bank. We feed 100's of people out of this garden, and we are only one of many gardens at the farm, all of which donate at least 50% to local food banks.

There are many farms in this impact area, it is one of the first open land as you travel north from Seattle, and is a very peaceful bit of nature amidst the endless city sprawl. We don't have a replacement property for the Red Barn Community Farm, which will be a huge loss to the families who have come to rely on this healthy alternative to the starches and canned goods one expects at a food bank. E16-1

There is a great amount of infrastructure requiring removal to make this plan work, including roads, and parks, this is a highly used recreation area as well.

I don't the project is a good use of the millions that would go into it. Please consider this email a strong vote for NO!

Sequoia Warner

206-240-0676

Lowell Community Food Bank

5218 S 2nd Ave,

Everett WA 98203

6.16.1 Response to Comment Letter E16

E16-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, you, the Lowell Community Food Bank, and other key stakeholders will be notified to ensure closer coordination in the future.

6.17 Comment Letter E17 – Walter Kuciej

From: Walter Kuciej
To: Nearshore
Subject: [EXTERNAL] Comment
Date: Tuesday, November 11, 2014 12:12:19 PM

I am in favor of the Puget Sound Nearshore Ecosystem Restoration Project. We need to create more habitat for wildlife and recreation. Thank you. Walter Kuciej Seattle WA.

E17-1

6.17.1 Response to Comment Letter E17

E17-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore.

6.18 Comment Letter E18 – Larry Jensen

From: Larry Jensen
To: Nearshore
Cc: Bill Schmidt; Ed Hoats
Subject: [EXTERNAL] survival -for or against!
Date: Tuesday, November 11, 2014 9:39:53 PM

Dear Dept of Fish and Wildlife and others,

I am writing this email in complete opposition to the proposed Puget Sound Nearshore Ecosystem Restoration Project (PSNERP).

I am a farmer and what you are proposing is to remove vital farm habitat from production for the human species and reduce our ability to produce a local, safe, food supply. If it is your desire to prevent us farmers from surviving then you are making the right move by proposing more farmable acres be turned into wetlands. You should keep going and you will prevent the survival of the farmers, the farm and locally produced food.

I would suggest instead if you wish to improve fish runs that you enhance existing habitat and control the harvest if you want to restore salmon runs.... for example nets in the river are counter to both.

NETS ARE BAD FOR HABITAT AND NETS ARE GREAT TOOS FOR HARVEST!

Please let the fish and the farmers survive.....no more nets and no more conversion of farmland!

Larry R. Jensen
Member of the Skagit County Farm Bureau
Member of the Skagit County Red Potato Growers Association

E18-1

6.18.1 Response to Comment Letter E18

E18-1: See Master Response 3.

6.19 Comment Letter E19 – Larry Jensen

From: Larry Jensen
To: Nearshore
Cc: Ed Hoats; Bill Schmidt; Ed Hussman; Ed & Roxanne Hussman; Jim Hinton
Subject: [EXTERNAL] JUST SAY NO!
Date: Tuesday, November 11, 2014 10:04:26 PM

To those in the know,

Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a formula for disaster!

That is right, you read me correctly.

Why should we spend all the proposed funds and all time when we don't know what the past efforts have yielded and we don't hear specifics on what exactly the proposed plan is to accomplish (ie: how many salmon is it to add to the run). Is there a cost benefit analysis you can show me that has been done to say the results to the farming community, the adverse economic costs, and does the cost to the tax payer justify the expense? This all seems to get lost in the desire for the agencies to build their kingdoms and take control over more of our lives and our resources. E19-1

I say no to anymore take over of our lives, no to more expense, and no to more taxes to pay for it, no to the loss of farm land, and no to the loss of more of our local food supply!

JUST SAY NO!

Larry R. Jensen
Farmer in the Marshland Drainage District
Snohomish County Washington.

6.19.1 Response to Comment Letter E19

E19-1: See Master Response 3. In addition, the Cost Effectiveness Analysis for the array of alternatives considered for implementation is presented in Section 4.5 of the Final Feasibility Report and Environmental Impact Statement.

6.20 Comment Letter E20 – Scott Bedlington

From: Scott Bedlington
To: Nearshore
Subject: [EXTERNAL] PSNERP
Data: Wednesday, November 12, 2014 1:32:23 PM

To whom it my concern

I am submitting a comment concerning the Nooksack River Delta Site of the Puget sound near shore ecosystem restoration project. We (Dick Bedlington Real Estate LLC and Bedlington Farms LLC) currently own approximately 425 acres in your area of your restoration project. All of this land is in agriculture production. We are not interested in selling these properties at any price. The project you are proposing would be detrimental to our company. Most of the other property owners I have spoken with no nothing about this and I think you should make the effort to contact them. Thank you for allowing this comment. E20-1

Please reply back to confirm you received this comment..

Scott Bedlington

Sales & Farm Manager

Dick Bedlington Farms

8497 Guide Meridian Rd.

Lynden, WA 98264

360-354-5264 Office

360-354-7619 Fax

Email: scott@bedlingtonfarms.com

Website: www.bedlingtonfarms.com

6.20.1 Response to Comment Letter E20

E20-1: Landowner willingness is a key component of restoration at the Nooksack River Delta. If Congress authorizes the recommended plan, landowner outreach will continue during the Preconstruction, Engineering and Design Phase. During this phase, the Corps and local sponsors will continue to work to refine the project designs in coordination with landowners and stakeholders, including Dick Bedlington Farms. If there are landowners who are unwilling to negotiate with study sponsors to provide necessary property, individual project sites will be modified and/or removed from the proposed restoration plan.

6.21 Comment Letter E21 – Greg and Jennifer KcKee

From: Greg
To: Nearshore
Cc: "Greg"; Jennifer; steve@nicollawfirm.com
Subject: [EXTERNAL] Nearshore North Fork Skagit River Delta Project (Parcel #P15515)
Date: Saturday, November 15, 2014 1:57:32 PM

Greg & Jennifer McKee
13735 Rawlins Road
Mount Vernon, WA 98273
360-445-3132

15 November 2014

Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, WA 98124-3755

Re: Nearshore North Fork Skagit River Delta Project (Parcel #P15515)

Dear Ms. Gleason,

We have recently been made aware of a project that has apparently been in the planning stages for a number of years and which directly affects us in an extremely significant way. To have found out about this by chancing across an article in the Skagit Valley Herald was surprising and very disappointing for us. Why were the impacted property owners not contacted prior to the public announcement (and still have not been contacted)?

We have lived on our property on the North Fork of the Skagit River since 1998 – 16 years this past August. This is the longest that we have lived in one home since we were married nearly 41 years ago. We love our home here on the Skagit and have poured much love, blood, sweat and tears into it over the years.

Our home was built in 1901 by the Summers family one of the area's most noteworthy pioneering families. They also started Phil's Boathouse which later became Blake's Resort when it was sold. We have devoted much time and effort over the years to maintaining and upgrading this fine old farm house – with many wonderful family gatherings here for birthdays and Christmas, etc. We just recently completed a new septic system installation and restoration project for which we invested approximately $55,000 dollars in order to keep the house and property in top notch shape both esthetically and functionally.

In 2007 I designed (Greg is an Architect retired) a timber frame office/studio/garage/workshop which our two sons and our son-in-law built for us – very much a family affair. The project was published in the October 2008 edition of Timber Homes Illustrated Magazine – being recognized as a notable project. E21-1

I (Greg) retired from my career as an Architect in 2012. Much of our time and effort in the ensuing couple of years has been directed toward preparing our home and property for sale. Much of our personal principal is wrapped up in our home and property – intended to provide for us as our retirement years progress. It is imperative that we are able to access those assets in the very near future.

Our grave concern today is that as soon as this project was announced, our land ownership has essentially gone into a state of suspended animation. We find ourselves in virtual limbo since we cannot move forward with any substantial plans for our home – you have taken away our ability to fully guide our own direction with our own lives at this point. We cannot list our property for sale and we feel it might be further money wasted to invest any more of our limited funds in maintenance or upgrade projects. This threatens our retirement years which we have looked so forward to enjoying – they are upon us. And, what is most irksome, it seems to have been thrust on us with little care or concern about the real-life impacts of the announcement – whether or not the project proceeds. Either way, if the project goes on to completion or is eventually abandoned, we are immediately and significantly impacted as far as our options as related to our dear home.

If this deliberation/feasibility phase proceeds for an extended period of time – we will continue to live in total limbo during that period. This is unacceptable to us at this stage in our lives – and imminently unfair for you to thrust this onto us.

At this time, knowing what we now know, we envision only two possible satisfactory outcomes – and either one should be arrived at in as short a period of time as possible:

1. Our property is purchased outright at a suitable price recognizing the profound impact this whole project is inflicting on us day-by-day or
2. Our property is left untouched with a dike being built around it to provide safety from the river and with appropriate access. E21-1

We feel that the worst possible scenario now that we are thrust into this unwanted situation would be for this deliberative process to extend out over several years and then to eventually have the project scrapped due to property-owner resistance or other negatively impacting criteria (i.e. denial of funding by Congress). In this scenario, we would have been forced to live this important part of our retirement years with the outcome of the project uncertain, the probability of our continued ownership in jeopardy and any impetus for continuing to perform appropriate upkeep, upgrades and maintenance projects to prepare to place our home on the market for sale being undermined and simply living every day of this prolonged process with this sword hanging over our heads.

Surely when this is examined on a personal level, as to how it will so profoundly impact us whichever way the project now proceeds, you must recognize that it is imperative that the land owners who are impacted must be handled respectfully, compassionately and fairly. Please don't lose sight of the human toll this project will take as you evaluate the proper path to follow. Too often we have seen these types of projects which are envisioned based on noble goals but which blindly emphasize some intangible end at the expense of real-life suffering and loss. We have already, even at this early stage, suffered loss – and this process has just begun for us. An unwanted hand grenade seemingly casually tossed into the midst of our long awaited and planned-for retirement years.

Best regards,

Gregory McKee Date Jennifer McKee Date

(signed copy to be mailed)

6.21.1 Response to Comment Letter E21

E21-1: Landowner willingness is a key component of restoration at the North Fork Skagit River Delta. If Congress authorizes the recommended plan, landowner outreach will continue during the Preconstruction, Engineering and Design Phase. During this phase, the Corps and local sponsors will continue to work to refine the project designs in coordination with landowners and stakeholders, including you. If there are landowners who are unwilling to negotiate with study sponsors to provide necessary property, individual project sites will be modified and/or removed from the proposed restoration plan.

6.22 Comment Letter E22 – Jennie Sheridan

From: [redacted]
To: Nearshore
Subject: [EXTERNAL] Public Comment Submission--Chamber's Bay
Date: Thursday, November 20, 2014 10:59:58 AM

Hello—

I am hoping that the Chamber's Bay area will be taken into consideration during the Puget Sound Nearshore Ecosystem Restoration Overview.

The north and south docks at Chamber's Bay were valuable nesting sites for purple martins, cliff swallows, pigeon guillemots, and ospreys. Colonies of bats (the most I saw at one time was 20-25) would fly in and out of the pilings of the docks in the evenings for insects. Below the surface of the water, marine life clung to nearly every single piling supporting the docks. Hundreds of starfish (mostly purple and ochre stars and leather stars—all seemingly unaffected by the "wasting" disease), giant and short plumose, painted, and green anemones, Lewis's Moon Snails, and a wide variety kelp and decorator crabs, not to mention feather duster worms, giant barnacles, creeping pedal sea cucumbers, Pacific blue mussels, and a rainbow of native sponges, all used the pilings of the dock as habitat.

With those docks now gone, a huge hole is left in what was a flourishing habitat. This summer alone, twelve martin pairs nested at the south dock and eight to ten pairs nested in the north dock. About ten pairs of pigeon guillemots occupied the back portion of the north dock and at least six pairs in the south dock. Thirty-two active cliff swallow nests lined the concrete ceiling of the north dock. All of these species have been returning to these two docks for years (at least the past fifteen years that I know of for sure, though I'm sure much longer) to nest and raise their young.

With the exception of six martin houses and a vacant osprey pole, no habitat plan has been put in place to compensate for the loss of these two docks. A plan needs to be put forth that incorporates habitat for both resident and migratory nesting birds and for marine life.

Part of the beauty of the docks was, while they served as valuable nesting sites, they were also accessible at low tide for the non-diving public to explore up close the rich diversity of Puget Sound marine life that clung to the pilings. The docks were a popular destination for families, day campers, and students. Ideally, a new habitat plan could include non-toxic posts placed in the water that would still be accessible at low tide. The posts—a grouping of or small "forest" of posts—could attract new marine life and could also be used to hold purple martin boxes and bat houses.

With State monitoring programs around Puget Sound and up and down the coast for starfish, it is important to bring back hard surfaces for them to cling to so that the public can monitor their status, especially considering the hundreds (during low-tide this summer, I counted over 600 purple and ochre and leather stars at the north dock clinging to the pilings above the water's surface with many more below the waterline) that have existed at these sites for decades. Because of over one-hundred years of gravel mining, the sea floor at Chamber's Bay is very sandy—almost pure sand—with no hard surfaces. The docks at Chamber's Bay were one of the very few accessible sites for the non-diving public to explore the diverse range of hard surface-clinging creatures that inhabit the Sound. E22-1

There are sites in Puget Sound that are manmade underwater diving parks with various structures laid out on the sea floor to accommodate and encourage surface-clinging marine life. If this idea could be put in place at Chamber's Bay, yet remain accessible to the non-diving public at low tide, the area could continue to be a hands-on classroom for the beach going public and students alike. The best way to achieve this while also providing nesting and roosting spots for migratory birds would be to install non-toxic posts in the water, similar to the piling habitat that was removed. While this idea may prove to be an expensive endeavor, it seems that part of the funds used to remove the piling and dock habitat in the first place, should be allocated to replace it.

I hope very much that some form of habitat replacement will be implemented at Chamber's Bay to encourage the many species—that dwell above the water's surface and below— that have thrived at the north and south dock for decades. Without any plan in place, we are bound to see a significant decrease in these species and some may become non-existent in the area. This is a significant loss for everyone.

Jennie Sheridan
Tacoma, Wa

6.22.1 Response to Comment Letter E22

E22-1: Thank you for your comment. At this time the Chambers Bay project is not included in the Corps' recommended plan for construction authorization. However, this site has been identified for future additional study and may be recommended for construction authorization in the future.

6.23 Comment Letter E23 – Ed Husmann, Snohomish County Farm Bureau

From: Ed Husmann
To: ed husmann; Newsstore
Subject: [EXTERNAL] PSNERP
Date: Thursday, November 20, 2014 8:13:02 PM
Attachments: PSNERP Comment.docx

Dear Sir or Madam ..... please add the attached letter to the PSNERP comment file as part of the official project. Thank you.

Ed Husmann
President, Snohomish County Farm Bureau

SNOHOMISH COUNTY FARM BUREAU

USACOE
nearshore@usace.army.mil

Dear Sir or Madam,

I and several other members of the Snohomish County Farm Bureau attended the 11/5/14 PSNERP meeting at the Burlington City Hall in Burlington, WA. We thank you for this opportunity to comment on the PSNERP draft FR/EIS. Please make us a party of record to the project and please give careful consideration to our comment below.

Comments

1. We find it dismaying to learn of the evident secrecy of the proceedings to date. At the 11/5/14 PSNERP meeting at the Burlington City Hall we learned that

♦ WDFW and the ACOE been working on this PSNERP for the past 12 or 13 years.

♦ WDFW and the ACOE spent over 22 million dollars to identify properties in the Puget Sound region for the Project

♦ Not until the 10/10/14 announcement by WDFW was the public advised of the existence of the Project and then the public was given only 45 days (deadline 11/24/14) to comment on the draft FR/EIS. E23-1

♦ There was no public involvement or notice of the scoping of the FR/EIS,

If the WDFW and ACOE wanted informed comment about the draft FR/EIS that has been 13 years in preparation, they would have allowed far more time for study of that document. It strongly appears that both government agencies are not acting in good faith but are attempting to slide one by the public.

2. We learned at the 11/5/14 meeting that NSPERP consists of 5,000 acres distributed over 11 Projects in six counties for a cost of $1.4B before cost overruns. No information was given to suggest that this is a cost-effective expenditure, or that similar projects in the past have been effective producers of salmon. E23-2

3. We learned at the 11/5/14 meeting that the premise of this Project is that there is a shortage of smolt habitat. Yet we also learned that the existing smolt habitat is not fully utilized. Therefore there cannot be a shortage of smolt habitat. E23-3

4. We learned at the 11/5/14 meeting that most if not all of the 5,000 acres are agricultural land under the Washington GMA and SMA, both of which mandate the protection of agricultural land. But the Project will destroy these 5,000 acres with daily saltwater pollution. E23-4

5. The 5,000 acres is presently habitat to various plants and animals. The Project will create a new habitat by destroying the present habitat. Hence E23-5

the Project will benefit one set of plants and animals while displacing another set. Why this constitutes a net gain remains to be explained. E23-5

6. We also learned at the 11/5/14 meeting that some of these 5,000 acres overlay previous projects in which considerable taxpayer funds were expended in the past. This is a waste. E23-6

7. The Project proponents misrepresent that the Project will "restore" the land to its pre-dike condition. ACOE & WDFW wants the public to believe that (1) the land was a swamp before it was diked, and (2) by removing the dikes the land will be returned to its pre-dike condition. #1 is probably false, and #2 is certainly false. Agricultural use has caused the land protected by the dikes to subside, and dike breach now will cause inundation and saltwater pollution never seen pre-dike. E23-7

8. ACOE & WDFW claim the Project will "reverse human-caused degradation". This "degradation" was the protection of farmland for production of food. This claim reveals a anti-human animus that calls into question the basic motivations of ACOE and WDFW lies behind this Project.

At its November 12th meeting, the Snohomish County Farm Bureau voted to oppose NSPERP by all available means. E23-8

Very Truly Yours,

Ed Husmann, President\
Snohomish County Farm Bureau

6.23.1 Responses to Comment Letter E23

E23-1: See Master Response 2. The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days. The Final Feasibility Report and Environmental Statement will be released for another 30 day review.

E23-2: The Cost Effectiveness Analysis for the array of alternatives considered for implementation is presented in Section 4.5 of the Final Feasibility Report and Environmental Impact Statement.

E23-3: There are a number of problems that this study intends to address, not just restoration of smolt habitat. First, large river deltas have been widely impacted by multiple alterations that significantly limit the size of the estuaries and degrade the nearshore ecosystem processes that support them. Next, many coastal embayments, including open coastal inlets, barrier estuaries, barrier lagoons, and closed lagoons/marshes, have been eliminated or disconnected from Puget Sound by the placement of fill, tidal barriers, and other stressors. In addition, stressors along beaches and bluffs have disconnected sediment inputs and altered sediment transport and accretion along long sections of the Puget Sound shoreline. Finally, the shoreline of Puget Sound has become much shorter and simpler, as well as more artificial. The cumulative effects of these multiple human-induced stressors threaten to overwhelm the ability of naturally occurring ecosystem processes to maintain structures, biological resources, and ultimately, the biodiversity and productivity provided by the ecosystem.

E23-4: See Master Response 3. At this stage of project design, GMA and SMA designations have not yet been confirmed because project footprints are still being refined. The Corps has initiated the process for compliance with the Farmland Protection Policy Act by providing the Farmland Conversion Impact Rating Forms to the Natural Resources Conservation Service for their review and input. When final project designs are available, the Corps will finalize the compliance process.

E23-5: The various plants and animals finding support in the present degraded acreage are in either in low numbers, are common around the Sound and not habitat-limited, or are non-native invasive species that outcompete high value northwest natives. Restoration would shift the balance toward the native species that people place greater value on, provide greater species diversity, and support much greater overall biological productivity.

E23-6: The projects included in the recommended plan are designed to be compatible with previous or nearby projects.

E23-7: The objective of Civil Works ecosystem restoration is to restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. The objective is not necessarily to restore to pre-settlement, pre-dike, or historical conditions, nor to reverse all human-caused degradation.

E23-8: Comment noted.

6.24 Comment Letter E24 – Michael Heath

From: [redacted]
To: Nearshore
Subject: [EXTERNAL] Farmed Island in deep water slough
Date: Friday, November 21, 2014 6:50:22 AM

Gentlemen; This Island is a unique piece of property that offers a lot of habitat for waterfowl. All this habitat will be lost if the dike is breached, and the opportunity to hunt a special area will be lost. I am not in favor of this project!
Michael W. Heath
Captain USNavy (retired)

E24-1

6.24.1 Response to Comment Letter E24

E24-1: See Master Response 1. The Deepwater Slough project is not being recommended for construction authorization at this time.

6.25 Comment Letter E25 – Barbara Brenner, Whatcom County Councilmember

From: Barbara Brenner
To: Nearshore
Subject: [EXTERNAL] Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report and Environmental Impact Statement Nooksack Delta Project
Date: Friday, November 21, 2014 9:44:28 AM
Attachments: PDF of letter Nooksack Delta Puget Sound Nearshore Ecosystem.pdf

Please see attached PDF of letter from me regarding: Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report and Environmental Impact Statement Nooksack Delta Project. A hard copy of was mailed on November 19, 2014.

Barbara Brenner, Councilmember

Whatcom Council

COUNTY COURTHOUSE
311 Grand Avenue, Suite #105
Bellingham, WA 98225-4038
Phone: (360) 676-6690

COUNCILMEMBER
Barbara Brenner

WHATCOM COUNTY COUNCIL

FROM THE DESK OF COUNCILMEMBER BARBARA BRENNER

November 19, 2014

Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, WA 98124

RE: Nooksack Delta Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report

Dear Ms. Gleason:

Since the above referenced project was first envisioned by your agency over a dozen years ago, Whatcom County has engaged in numerous open, transparent, and inclusive processes to identify natural resources that are integral to maintaining and improving our county's quality of life. As a council member, I greatly value our working lands (farms, ranches, and forests). These lands provide food, fiber, raw materials, energy, and contribute greatly to our local economy. I also understand our lands provide critical environmental resources, such as fish, wildlife habitat, and hydrologic functions. We need all of these very important resources to maintain and improve Whatcom County. I urge you to not trade one essential part of our county for another. I believe much of your work has so far been done in a virtual vacuum, which has caused concern and distrust from our community, including me. E25-1

I believe your proposal can be a win-win for your agency and our county, as long as the local community is involved and we do not lose any agricultural land base. Our Comprehensive Plan calls for no net loss of agricultural land. We are also the seventh leading agricultural producing county in the state and intend to remain at that level or better. Our community has local ideas that can alleviate concerns and promote a better outcome for all. For instance, our county's Purchase of Development Rights program and committee could help you identify farmland in jeopardy of conversion to development, which could potentially offset some of your proposals. We could also use that program on other lands to offset environmental impacts. Whatcom County is developing an Environmental Services Market Place that is founded on free market principles. I believe we can assist you in creating proposals for high habitat and/or hydrologic values without sacrificing productive agricultural land.

In summary, I hope and expect any proposals from your agency will ensure our local Whatcom County community is fully engaged. I also request any proposals incorporate local priorities and projects. I believe together we can create workable projects that will ensure adequate water for farms and the environment.

Sincerely,

Barbara Brenner, Councilmember
Whatcom County Council

BB:nh

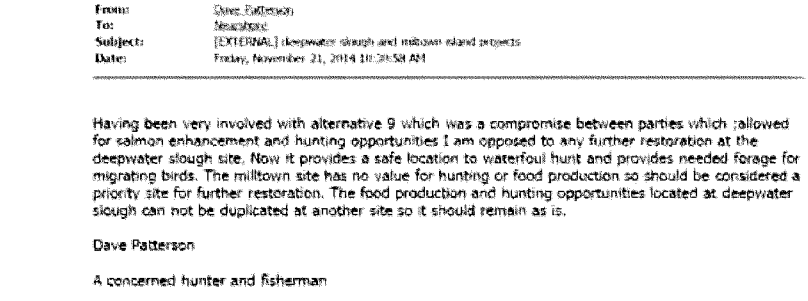
C: Dana Brown-Davis, Clerk of the Council
Correspondence File

I:\COUNCIL\Barbara Brenner\2014\ Puget Sound Nearshore Ecosystem

6.25.1 Responses to Comment Letter E25

E25-1: See Master Response 3. The Corps will continue to coordinate with Whatcom County, landowners, and key stakeholders as project designs for the Nooksack River Delta are refined.

6.26 Comment Letter E26 – Dave Patterson



From: [redacted]
To: [redacted]
Subject: [EXTERNAL] deepwater slough and milltown island projects
Date: Friday, November 21, 2014 10:26:58 AM

Having been very involved with alternative 9 which was a compromise between parties which ;allowed for salmon enhancement and hunting opportunities I am opposed to any further restoration at the deepwater slough site. Now it provides a safe location to waterfoul hunt and provides needed forage for migrating birds. The milltown site has no value for hunting or food production so should be considered a priority site for further restoration. The food production and hunting opportunities located at deepwater slough can not be duplicated at another site so it should remain as is.

E26-1

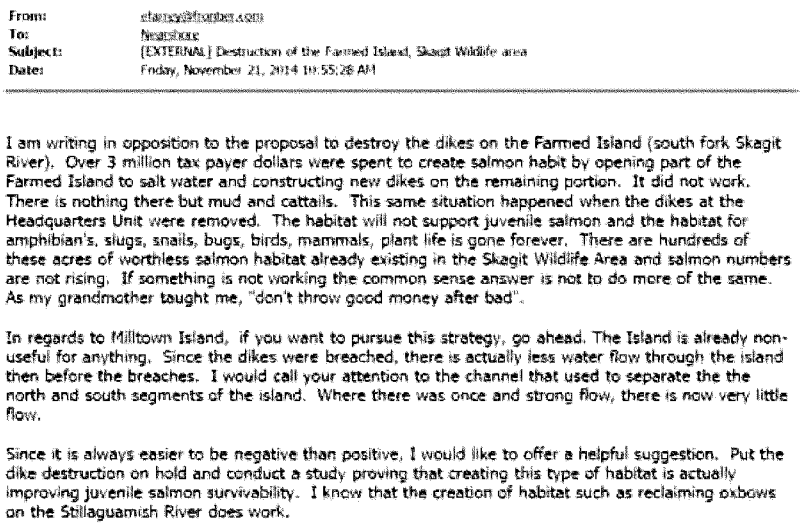
Dave Patterson

A concerned hunter and fisherman

6.26.1 Response to Comment Letter E26

E26-1: See Master Response 1. The Deepwater Slough and Milltown Island projects are not being recommended for construction authorization at this time. The Corps will continue to evaluate potential impacts to waterfowl hunting opportunities if either site is carried forward in the future.

6.27 Comment Letter E27 – Edward Farrey



From: [redacted]
To: [redacted]
Subject: [EXTERNAL] Destruction of the Farmed Island, Skagit Wildlife area
Date: Friday, November 21, 2014 10:55:28 AM

I am writing in opposition to the proposal to destroy the dikes on the Farmed Island (south fork Skagit River). Over 3 million tax payer dollars were spent to create salmon habit by opening part of the Farmed Island to salt water and constructing new dikes on the remaining portion. It did not work. There is nothing there but mud and cattails. This same situation happened when the dikes at the Headquarters Unit were removed. The habitat will not support juvenile salmon and the habitat for amphibian's, slugs, snails, bugs, birds, mammals, plant life is gone forever. There are hundreds of these acres of worthless salmon habitat already existing in the Skagit Wildlife Area and salmon numbers are not rising. If something is not working the common sense answer is not to do more of the same. As my grandmother taught me, "don't throw good money after bad".

In regards to Milltown Island, if you want to pursue this strategy, go ahead. The Island is already non-useful for anything. Since the dikes were breached, there is actually less water flow through the island then before the breaches. I would call your attention to the channel that used to separate the the north and south segments of the island. Where there was once and strong flow, there is now very little flow.

E27-1

Since it is always easier to be negative than positive, I would like to offer a helpful suggestion. Put the dike destruction on hold and conduct a study proving that creating this type of habitat is actually improving juvenile salmon survivability. I know that the creation of habitat such as reclaiming oxbows on the Stillaguamish River does work.

Having the funding and ability to do something does not mean it needs to be done.

Sincerely,
Edward Farrey

6.27.1 Response to Comment Letter E27

E27-1: See Master Response 1. The Deepwater Slough and Milltown Island projects are not being recommended for construction authorization at this time. The Corps will continue to evaluate potential impacts to waterfowl hunting opportunities as well as salmon survivability if either site is carried forward in the future.

6.28 Comment Letter E28 – Henry Bierlink

From: Henry Bierlink
To: Nearshore
Cc: Bradley Smith; Brett Pehl; Chuck Anthole; Dale Bedlington; Don Fuchter; Gayette Delis; Lesa Baux; Mabery Jon; Marty Maberry; Sherm Polinder; [illegible]
Subject: [EXTERNAL] comments on PS Nearshore Ecosystem Restoration project
Date: Friday, November 21, 2014 1:20:36 PM

November 21, 2014

Via Email

Nancy C. Gleason U.S. Army Corps of Engineers CENWS-EN-ER P.O. Box 3755, Seattle, WA, 98124

Re: Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report and Environmental Impact Statement. -- Nooksack Delta Project

Dear Nancy C. Gleason:

Whatcom Farm Friends is concerned about the scope and effect of the potential restoration project envisioned in the Nooksack River Delta. While we are open to cooperating on projects that enhance water quality and habitat we must consistently weigh these goals against the community's goals to support a sustainable agricultural economy.

Whatcom County has identified 100,000 acres of productive farmland as our goal for the minimum number of acres protected for farming. Approximately 1,000 of those acres are in or are affected by this project. We request that project proponents address the question of how removal of this land from farming is mitigated. This requires much more than just a fair price for the owner of the farmland. It means locating new land within the area for agricultural production or an enhancement of existing farmland to equal the loss of productive capacity caused by the project. These costs need to be developed and incorporated into the project budget.

E28-1

We trust that you will fully address these concerns before advancing this project in Whatcom County.

Henry Bierlink, Executive Director

Whatcom Farm Friends
1796 Front Street
Lynden, WA 98264
360-354-1337 hbierlink@wcfarmfriends.com <mailto:hbierlink@wcfarmfriends.com>

Agricultural Advocacy, Education & Awareness

6.28.1 Response to Comment Letter E28

E28-1: See Master Response 3. The Corps will continue to coordinate with Whatcom County, landowners, and key stakeholders as project designs for the Nooksack River Delta are refined.

6.29 Comment Letter E29 – Joseph Kelly

From: joseph kelly
To: Nearshore
Subject: [EXTERNAL] Nooksack wetland restoration
Date: Sunday, November 23, 2014 11:19:49 AM

The Nooksack was historically one of the most productive streams in the Puget Sound. Most of that productivity has been lost, due in part to habitat loss.

I feel that every effort should be made to restore the habitat and gain back some of the productivity loss. Habitat restoration should be a primary consideration on all of the waters in Puget Sound.

E29-1

Joseph M. Kelly

6.29.1 Responses to Comment Letter E29

E29-1: Thank you for your comment. The Corps is carrying forward the restoration project at the Nooksack River Delta and continues to evaluate other opportunities for restoration across all of the Puget Sound nearshore.

6.30 Comment Letter E30 – Tom Kearns

From: Tom Kearns
To: Nearshore; Bob Blake
Subject: [EXTERNAL] DeepWater Slough Project
Date: Monday, November 24, 2014 11:11:38 AM

I do not support this project as it will destroy 200 acres of prime wetland habitat to become a single monoculture for only fish.

No evaluation of economics, and total ecological improvement has been prepared to determine its impact. No engineering data, etc. has been presented in sufficient detail to truly understand its impact.

I suggest the USACE and WDFW consider first obtaining 200 acres and turn it into a wetland in the same general vicinity before draining the proposed project area. Then after building a new wetland, monitor for 12 years before constructing the proposed project. The waiting period would correspond with the hatchery limitation that has been placed on the Skagit River. The waiting period will produce data that will be a single element change in the environment that can indicate the wisdom of the wild fish only restriction.

E30-1

Also before doing anything, develope a ecological benefit of all fish and wildlife impact for this project. It appears the project is based upon bureaucratic and political justification for a single species rather than a total ecological system.

6.30.1 Response to Comment Letter E30

E30-1: See Master Response 1. The Deepwater Slough and Milltown Island projects are not being recommended for construction authorization at this time. An evaluation of economic costs and ecological benefits will be completed if this project is carried forward by the Corps in the future.

6.31 Comment Letter E31 – Daniel Tepper, Whatcom Parks and Recreation Foundation

From: Daniel Tepper
To: Nearshore
Cc: Michael McFarlane; Dan Taylor
Subject: [EXTERNAL] Puget Sound Nearshore Ecosystem Restoration Project
Date: Monday, November 24, 2014 11:17:20 AM

Dear Ms. Gleason,

Re: Puget Sound Nearshore Ecosystem Restoration Project--Nooksack River Delta segment

My name is Daniel Tepper and I am the President of the Whatcom Parks and Recreation Foundation. On behalf of the Foundation and the Nooksack Loop Trail committee (which comes under our purview) I would like to thank you for the opportunity to comment on the PSNERP and in particular the Nooksack River Delta segment. This is an exciting project and one which we generally support. We do, however, have some concerns and also see some opportunities with the project.

Our primary area of concern is along the east side of the Nooksack River between Slater Road and Marine Drive. In our opinion, partial removal of the levee on that side of the river should be done on a limited basis with culverts or small bridges spanning the breaches so that the trail is not obliterated. Maintaining and enhancing the existing trail will allow the continued use by hunters, fishers, bird watcher, walkers, etc. In addition, it will create a unique educational opportunity for the public with appropriate signage educating trail users about the surrounding environment. E31-1

The second opportunity/concern is the need to include a crossing under Slater Road as part of the Tennant Creek Bridge project. This would, of course, have to be closed when the Nooksack River is approaching flood state however this would be just a few times of the year at most. The remainder of the time it would provide safe non-vehicular access under Slater Road. This would also allow the possibility of removing one of the two Washington State Department of Fish and Wildlife parking lots now located on each side of Slater Road. E31-2

And finally, I would like to add that Whatcom County has long had a strong interest in establishing trail connectivity along the Nooksack River. Indeed, the County has adopted numerous trail plans for well over 45 years outlining this desire including the most recent update of Whatcom County's comprehensive plan. The Nooksack Loop Trail referenced in the first paragraph is a manifestation of those desires and adopted plans and, by extension, the general public's interest in maintaining access to and along the Nooksack River. Hopefully, as the PSNERP project moves forward, these long-held trail plans will be taken in to account and accommodated. E31-3

Thank you again for the opportunity to comment on the PSNERP project. When the project gets to a more detailed planning stage, we would be pleased to work with you.

Sincerely

Daniel Tepper

dtepper@sthmcross.com

Tel. 360-738-2939 - office

President

Whatcom Parks and Recreation Foundation

PS – For more information on the Nooksack Loop Trail, please see www.nooksacklooptrail.org .

6.31.1 Responses to Comment Letter E31

E31-1: The Corps will evaluate a possible design modification on the east side of the Nooksack River per the comment. Additional design refinements will occur during the Pre-Construction, Engineering, and Design Phase.

E31-2: The Corps will evaluate a possible design modification to include a crossing under Slater Road. Additional design refinements will occur during the Pre-Construction, Engineering, and Design Phase.

E31-3: Recreational opportunities including trails will continue to be evaluated as project designs are refined during the Pre-Construction, Engineering, and Design Phase.

6.32 Comment Letter E32 – Justen Graham

From: [redacted]
To: [redacted]
Subject: [EXTERNAL] Public Comment on Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)
Date: Monday, November 24, 2014 11:27:11 AM

Hello

I am writing to express our opinion on the Puget Sound Nearshore Ecosystem Restoration Project specifically regarding the Nooksack River / Marietta area.

My mother Margaret - who is 75 years old - has lived at her house, which was built in the 1920s at 1850 Marine Drive in downtown Marietta for 22 years. Neither she nor any of her neighbors were informed of the 'community commentary meeting' on November 5th and only after I read the article in the Bellingham Herald November 7th did she know of this 'meeting' or comment period. This meeting was held in Burlington 40 miles away from the site in another county.

This seems very underhanded, not only in not informing the residents affected but then also holding the 'community commentary meeting' in another county.

My mother has worked hard to help build a stronger peaceful community over the last 22 plus years and now, when things are at the most peaceful and rural, in a crunched housing climate with skyrocketing costs, on a minimal social security benefit is supposed to relocate and find a 2 bedroom home with likened acreage for her long time established gardens, her pony (named Marietta), 6 cats, 2 dogs, 6 chickens and cockatiel.

This situation is causing my mother extreme stress, anxiety and sadness at the thought of losing the home and place where she has worked and planned to live out her life and to hand down to her family. E32-1

Marietta is originally an ancestral fishing and ceremonial village of the Lummi tribe. It is located on the extreme edge of the 'restoration ' zone and should be recognized and preserved, not eliminated.

It appears as though it was added as an appendix on the project map, an annexation of questionable purpose.

The Silver Reef Casino (which was recently built and then expanded) is located in the middle of the historical flood zone delta of the Nooksack River. The casino has been exempted from relocation.

Marietta, a longtime established community on the extreme edge of the 'restoration zone', which historically existed as a fishing village and ceremonial meeting place before the white settlers came, has not been exempted. The more recent historical perception of Marietta as a 'low income minority blight' is obviously easier to target, and chase a handful of landowners and farmers off of their lands than the tribal casino even though the casino is in the 'restoration' zone.

This restoration project involves massive expenditure, and appears to be a money grab from the local taxpayers and federal government, and a cleaning house exercise.

Our family is very opposed to it.

Justen Graham
Lisa Kuhn
Margaret Keehn
Faye Lane
William Lane Jr

6.32.1 Response to Comment Letter E32

E32-1: The 1999 Whatcom County Flood Hazard Management Plan identified relocations of the Marietta area as a recommendation for possible implementation. At this time, the County is pursuing relocations of this area and the Corps has included this action in the proposed project at the Nooksack River Delta for consistency The Corps will continue to coordinate with Whatcom County and the community of Marietta as project designs are refined and potential relocations are confirmed.

6.33 Comment Letter E33 – Robert Hughes

From: Hughes, Robert D
To: Nearshore
Subject: [EXTERNAL]
Date: Monday, November 24, 2014 3:31:01 PM

Just what does 'restoration' mean? Are these beaches private property? By what authority are public funds used for such a project? E33-1 E33-2 E33-3

ROBERT D. HUGHES
A-5689 (253) 486-9688 (425)237-6089
CUSTOMER SERVICE REPRESENTATIVE
CUTTING TOOL SERVICE CENTER
FABRICATION DIVISION
BLDG 17-10
AUBURN, WA.
http://ctsc.web.boeing.com/ <http://ctsc.web.boeing.com/>

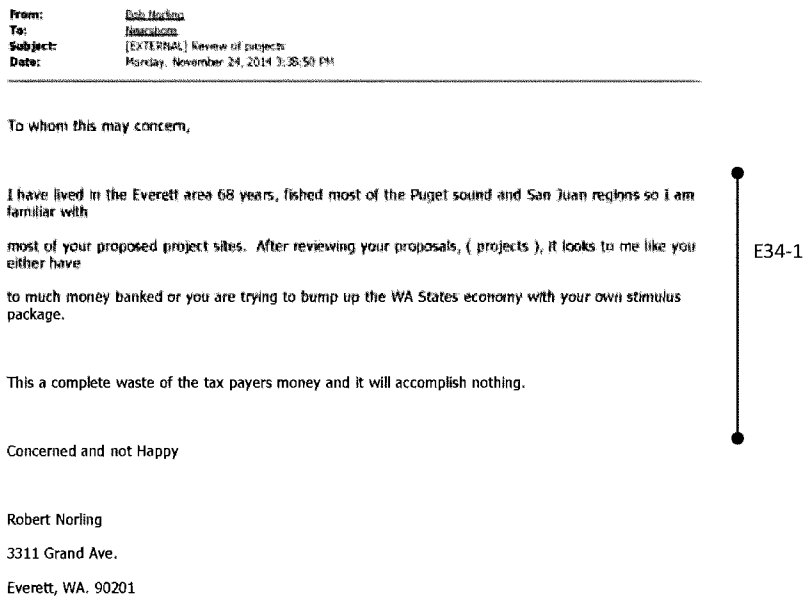
6.33.1 Responses to Comment Letter E33

E33-1: The Puget Sound Nearshore Study has identified guiding principles for nearshore ecosystem restoration that favor process-based restoration over species-based restoration. Process-based restoration includes intentional changes made to an ecosystem to allow natural processes (such as erosion, accretion, accumulation of wood debris, etc.) to occur. This restoration typically involves actions supporting or restoring the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., salmon production, bivalve production, and clean water). Process-based restoration is distinguished from species-based restoration, which aims to improve the services an ecosystem provides to a single species or group of species as opposed to improving elements that support the entire ecosystem.

E33-2: Project sites require a mix of public, private, and tribal property interests. Real estate interests will continue to be confirmed as project footprints are refined during the Pre-Construction, Engineering, and Design phase.

E33-3: This Puget Sound Nearshore Study is authorized under Section 209 of the River and Harbor Act of 1962 (Pub. L. 87–874). Additional Congressional authorization and appropriation is required before this project is constructed.

6.34 Comment Letter E34 – Robert Norling



From: Bob Norling
To: Nearshore
Subject: [EXTERNAL] Review of projects
Date: Monday, November 24, 2014 3:38:50 PM

To whom this may concern,

I have lived in the Everett area 68 years, fished most of the Puget sound and San Juan regions so I am familiar with

most of your proposed project sites. After reviewing your proposals, (projects), it looks to me like you either have

to much money banked or you are trying to bump up the WA States economy with your own stimulus package.

This a complete waste of the tax payers money and it will accomplish nothing.

Concerned and not Happy

Robert Norling

3311 Grand Ave.

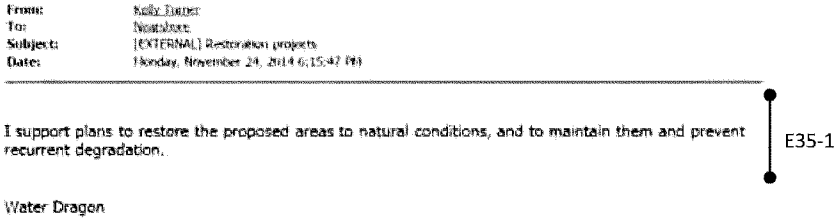
Everett, WA. 90201

E34-1

6.34.1 Response to Comment Letter E34

E34-1: Comment noted.

6.35 Comment Letter E35 – Kelly Turner



From: Kelly Turner
To: Nearshore
Subject: [EXTERNAL] Restoration projects
Date: Monday, November 24, 2014 6:15:42 PM

I support plans to restore the proposed areas to natural conditions, and to maintain them and prevent recurrent degradation.

Water Dragon

E35-1

6.35.1 Response to Comment Letter E35

E35-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound Nearshore.

6.36 Comment Letter E36 – Pete Franett

From: Pete Franett
To: Shorelands
Subject: [EXTERNAL] 11 potential PSNERP projects
Date: Monday, November 24, 2014 10:17:47 PM

To whom it my concern,

I am opposed to the 11 potential PSNERP projects for two main reasons:

1) Financial burden to the taxpayer: The state of Washington is facing some major financial obligations when the legislature reconvenes, most notably the supreme court McCleary decision and Initiative 1351. As a taxpayer I can't afford to pony up an additional $260 million to $385 million (depending on your source of information) of state money for a project not as pressing as others already on the table. E36-1

2) Taking farmland out of production: In eight of the ten potential projects north of Everett there are references to current agricultural use. I am assuming that this land will be taken out of agricultural use when the dikes come down. Until we find other ways of providing affordable food for a growing population I am absolutely opposed to taking farmland out of production. E36-2

Sincerely,

Pete Franett

144 Young Road

Kelso, WA

98626

Regards,

Pete Franett

(360) 636-5005

pbfranett@wildblue.net

6.36.1 Responses to Comment Letter E36

E36-1: Congressional authorization and appropriation is required before this project is constructed. Following completion of the Final Feasibility Report and Environmental Impact Statement, the Corps will forward the project recommendation to Congress for their review. If Congress endorses the recommendation, it is anticipated that they would provide authorization for construction in a Water Resources Development Act, which is typically passed every 2- 7 years. The authority to construct, however, does not equate to the funding for the design and construction phase, which would be addressed annually in the Federal budget and biannually in the state budget. This project will compete for funding at the local, regional, and national level.

E36-2: See Master Response 3.

6.37 Comment Letter E37 – Suzanne Phillips

From: suenh
To: Nearshore
Subject: [EXTERNAL] In opposition to PSNERP
Date: Tuesday, December 02, 2014 9:31:42 PM

To the Corps of Engineers:

I write this in opposition to your PSNERP study.

At over one Billion dollars, it's too expensive. And it's also unnecessary.

Through round-about and underhanded dealings and regulations, making it near impossible to carve out a living as a farmer, and by government entities (Counties, Cities) outbidding local farmers when land is for sale, farming is slowly but surely being nudged out of the Pacific Northwest.

Judging from the scope of your study, (five thousand acres), Western Washington farmers are no longer being nudged out of our region... they are being pushed. E37-1

Please do not take part in this scheme, which has shattered beyond heartbreak the livelihoods of so many Puget Sound farming families, as well as the farming culture of our region.
Farms are every bit as essential to human life as shellfish and salmon.

Furthermore, there is an appalling LACK of scientific data to justify more "restoration" studies and experiments in the Puget Sound region.

During the last decade, a number of these projects have been either completed or are well underway. Surely these sites can serve to produce adequate data without flooding more open space.

Furthermore, a literature review of this field indicates a much greater need for accurate fish counts than restoration efforts; especially in existing estuaries and within the marine waters of the Puget Sound. Without those counts, there is no proof that "restoration" is even necessary. E37-2

To date, in our region, literally billions of tax dollars have already been spent on these experiments, and none have been successful in bringing back significant numbers of the targeted endangered species, and none have facilitated their deletion from the endangered/extinct species list.

Repeating these exercises is a sorry waste of your time and talent... and our money.

There is no reason to throw good money after bad.

Sincerely,

Suzanne Phillips

7915 72nd Dr. NE

Marysville, WA 98270

6.37.1 Responses to Comment Letter E37

E37-1: See Master Response 3. Project sites require a mix of public, private, and tribal property interests. Proposed ecosystem restoration projects included in the recommended plan are intended to be compatible with ongoing farming and agricultural practices while still maintaining recreational opportunities for public users. Real estate interests will continue to be confirmed as project footprints are refined during the Pre-Construction, Engineering, and Design phase.

E37-2: Analysis of the complex Puget Sound Nearshore system was based on the scientific guidance provided by the Nearshore Study's interdisciplinary team of scientists. The Nearshore Science Team has overseen the delivery of a series of peer-reviewed technical reports that provide the foundation of the Nearshore Study. These analyses led to identification of a problem of national significance, and to planning objectives necessary to address identified issues. The results of the Nearshore Study are based on a comprehensive analysis of historical and current conditions in the Puget Sound Nearshore zone. Technical reports characterize the impacts of shoreline and watershed alterations on Nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed through restoration.

6.38 Comment Letter E38 – Caroline Armon

From: CaBoard Tours
To: Nearshore
Subject: [EXTERNAL] PSNERP Comment
Date: Thursday, December 04, 2014 5:14:58 PM

Dear Ms. Nancy C. Gleason,

I fully support the PSNERP and all actions to restore, preserve, and conserve the Salish Sea. E38-1

Thank You!
Caroline Armon
Marine Educator, Naturalist, Captain, and Tour Guide
www.onboardtourswhales.com <http://www.onboardtourswhales.com/>

6.38.1 Response to Comment Letter E38

E38-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound Nearshore.

7 Individual Mailed Comments and Responses

7.1 Comment Letter M1 – Kurt Zwar

tober 18, 2014

Nancy C. Gleason
US Army Corp of Engineers
CESWS-EN-ER
P.O. Box 3755
Seattle, WA 98124-3755

Re: PSNERP draft feasibility report

Dear Ms. Gleason,

My name is Kurt Zwar. I am a volunteer with the WDFW and have worked on the Skagit Big Island (aka: Farmed section of Skagit Wildlife Area) since 2011. I have a degree in Zoology (1973) from the University of Washington and taught high school biology.

I have been involved in habitat restoration on the Skagit Big Island and have monitored amphibian populations there. I have enclosed habitat and species photographs (CD - photo) and communications I have had with several WDFW scientists, especially regarding the wonderful riparian, wetland and woodland habitat that the Skagit Big Island is.

This island in the middle of the South Fork of the Skagit River is the second on your list for restoration as the Deepwater Slough runs through the island.

This island is a tremendous amphibian, reptile, avian and mammal habitat. The fresh waters of the Skagit River feed this environment. It is home to a wide variety of animals including nesting Bald Eagles, Northern Red-legged frogs, Northwestern salamanders, garter snakes, turtles, beavers (whose work enhances the entire island ecosystem), otters, black tailed deer, muskrats, martin, coyotes, blue heron, bittern, hawks, many more species of birds including songbirds, shorebirds and waterfowl. Snipe, a native shorebird nests on the Skagit Big Island. Many other birds species nest there too.

This amazing place is home to a fast disappearing entity in Washington state.....a safe place for amphibians to survive....protected by geology and man....so far. With over 80% of wetlands already destroyed in Western Washington, it would be a tremendous tragedy to lose this incredible place. Everyone who visits the Skagit Big Island comes back amazed at this wild and wonderful place.

I am afraid that all of this will be lost with a planned project on the Deepwater Slough going through the middle of the island. If the dikes there are breached, salt water will destroy the habitat there for all of the animals that live there. For over 100 years this island and it's native inhabitants have been protected. Now that protection is in jeopardy. Open the dikes and all of these animals die. All of the habitat will be permanently lost.

Destroying dikes on the Skagit Big Island will destroy riparian, wetland and forest habitat. It is too much and too high a price for an absolutely rare, beautiful and unique habitat. Not protect this island in the face of rapidly dwindling wetland habitat in Washington state? On the Skagit River? Save this place for all who are there now. The amphibians, reptiles, birds and mammals live in this habitat. We should be saving this rare and beautiful place. It should be treasured for what it is and for the huge wildlife population that calls it home already. It is not just some field to be flooded with saltwater. It is

M1-1

extremely valuable and rare wildlife habitat. Please protect this land, and the animals that call it home. Please, do not destroy it.

The Skagit Big Island is a treasure of the Skagit Wildlife Area. It has been used by duck hunters for over 100 years. When this island farm was sold in 1953.....it was purchased by the Washington State Game Department. Not fisheries or anyone else. It was purchased to help maintain habitat and duck populations and to provide continued access to hunters who have experienced and respected this wild place. It is perfectly clear that the purchase of the island from Carl and Anna Marie Lorenzen in 1953 by the Game Department was to maintain habitat, duck populations, hunting access and traditions. That tradition continues to this day. Local hunters often bring their kids to the Skagit Big Island for their first hunts as it is a safe place for the young ones. I hunted there first when I was 14. Many Washington citizens know this special place. Skagit county Boy Scout troops have worked on the island building safe and sturdy duck blinds for all to use.

I am asking that the Corp of Engineers and the WDFW look at the Skagit Big Island as an invaluable place that needs to be saved. Saved for the amphibians in a much harsher world that we now live in. Saved for the thousands of other animals that live there also. Saved for the hunters who have hunted there for over 6 generations. And saved for all our future. I hope we have not become so callous as to destroy this island without looking at its threatened inhabitants like they are not there and do not count. Like this beautiful land does not exist?

Whatcom County has recently been found (by the WDFW) to have an existing population of the exceptionally rare Oregon Spotted Frog, an EPA endangered animal. I was looking and listening for the Oregon Spotted Frog on the Big Skagit Island. They are native in Skagit County too.

There are many places very close to the Skagit Big Island that can be converted to tidal land as is the case with Milltown Island just south. The Skagit Big Island is much too valuable and rare to deserve that fate.

Belinda Rotton, manager of the Skagit Wildlife Area and John Garrett, the former manager can verify my work there.

M1-1

Thank you for your consideration on the Skagit Big Island.

Sincerely,
Kurt Zwar

Kurt Zwar
3954 NE 115th St.
Seattle, WA 98125
206 362-2477
maplest327@aol.com

cc:

Belinda Rotton – Manager Skagit Wildlife Area
21961 Wylie Road
Mt. Vernon, WA 98273
360 445-4441
360 445-2093 (fax)

Other public comment materials received held by Corps office, but not included here:

- WDFW News Release re: PSNRP public meeting, dated 10/10/2014
- Whatcom County Amphibian Monitoring Project, Oregon Spotted Frog, dated 10/19/2014
- Metro Park Tacoma news release re: Reintroduction of Oregon Spotted Frog, dated 10/2/2014
- Correspondence between Kurt Zwar and WDFW re: Skagit Big Island Frog Survey, various dates
- CD on the Skagit Big Island, dated 4/2011

7.1.1 Response to Comment Letter M1

M1-1: See Master Response 1. The Deepwater Slough project is not being recommended for construction authorization at this time. The Corps will continue to evaluate potential impacts to amphibians, reptiles, birds, mammals, and waterfowl hunting opportunities as described in your letter if this site is carried forward in the future.

7.2 Comment Letter M2 - Curt Young

Comments on - Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Draft Feasibility Report and Environmental Impact Statement

I am no stranger to wetlands for I am a retired biologist which spent 32 years reviewing environmental impact statements and managing wetlands, including Spencer and Ebey Islands.

First, if the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) was submitted by a non-government entity it would not be given any hope of progressing. Each project within this document is unique and must have its own environmental impact statement. To lump 11 projects into one document and request comments as one EIS, in 45 days, is laughable, but the government did it because they can. Below I would like to add my comments which generally apply to all the projects. M2-1

Cost Estimates and Benefits – Cost is purely an educated guess if everything goes perfectly. Also a low cost estimate has a much better chance of approval and funding. But the original estimate is usually not even close to the actual cost. I am sure everyone has read about projects that are way beyond budget (big Bertha anyone?), so it is reasonable for readers to inflate the cost estimates by a factor or three or more to get something close to reality. And with similar logic, is it beneficial for project approval to estimate benefits as high as possible. In reality, the expected benefits rarely meet expectations. M2-2

Restoring Wetlands – all of the lands are already wetlands, if you doubt this try getting a building permit. These wetlands already support a large variety of wildlife. If grazed, wetlands host a huge variety of waterfowl, hawks, owls, shorebirds, frogs, and song birds. If the area is returned to tidal mud flats where is the habitat mitigation for these species? M2-3

Enhancing Salmon Habitat – When the south end dikes of Spencer Island were breached in about 1990 there were great expectations for fish use. The fish use and habitat changes were monitored extensively by State, County, and Federal agencies, but the expected increase in fish use was minimal, while the costs were substantial. The same applies to breaching the dikes for Diking District 6. The county bought the entire district with one of the main justifications as fish enhancement. The costs were high but fish benefits were very low. M2-4

Increasing Salmon Population – the cheapest way to increase fish numbers is to build and operate a hatchery. Critics point out the low return rate and impact on native fish. But the reality is there is no net loss of fish. Orcas and marine mammals are fed by the hatchery fish, as well as diving ducks like grebes and scoters, all of which are either endangered or on the threatened list. It is not feasible to raise any of these non-fish species in a hatchery, but one can raise salmon and trout and the "loss" is a gain for the other species. Even fish that are not eaten will die and provide food for insects, which in turn are food for fish. In addition, if you believe in global warming the future of "native" salmon is not very rosy. The rivers will be subject to more quick flooding which scours the gravel where the eggs are laid. This results in a loss of an entire generation of young. In addition, the rivers will be lower in the summer causing warmer waters and fish stranding. The ocean is also becoming warmer and less productive. Perhaps to maintain the legacy of the Northwest salmon a new stain of salmon needs to be developed more adapted to the future environment. Currently native salmon and trout genes are used for hatchery fish. Nature does not stay constant, only a person's hopes that they can bring back historical conditions. M2-5

Farmland and Water – As the climate becomes drier at some point there will not be enough water to M2-6

make it feasible to farm the deserts of Washington and California. Already California is questioning the use of water to farm the San Joaquin valley. The sub-irrigated lands of western Washington, lands like Everett Marshland, may be prime farmland in 20 years. With this proposal it will be mud flats, and other agricultural lands will be returned to salt water. The productive Kent valley has long since been lost to several feet of gravel and blacktop. Do we want local products, or pay the price of hurning fossil fuels to have them shipped from China or Brazil? M2-6

The bottom line is that society can never bring back salmon, or trout, and shoreline habitats to what it was in the past. There are too many pressures on the land and waters to satisfy the needs of people for homes, roads, business, timber, fish, recreation, etc. Some habitat modification projects make sense, but it takes more detailed analysis and a vision of what is needed 20 years in the future. Given a ball park figure of $25 million for construction of just one fish hatchery, spending taxpayer funds of $1.2 to 4 trillion for the 11 projects is a poor investment if the primary purpose is for increasing fish numbers. M2-7 M2-8

Curt Young
retired WDFW biologist
Snohomish, WA

7.2.1 Responses to Comment Letter M2

M2-1: The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days. The Final Feasibility Report and Environmental Statement will be released for another 30-day review.

M2-2: Cost estimates include conservative contingencies. Cost estimates have also been escalated to the anticipated year of construction in order to capture potential increases in costs.

M2-3: Projections of wetland abundance in the nearshore zone depend on a variety of factors including land development and zoning, regulatory permitting and enforcement, mitigation requirements, sea-level change, and climate change. During the next design phase, the potential effects of habitat changes would be thoroughly analyzed and all appropriate permits would be obtained prior to construction.

M2-4: Each of the three sites included in the recommended plan has a monitoring and adaptive management plan developed for use after project construction. The goals of the monitoring plans are to determine whether the management measures applied to the sites are producing the desired effects and to determine whether corrective action is needed to improve effectiveness. The site-specific monitoring plans contain metrics and performance targets that are tied to evaluation of project objectives. These performance targets, if not met, will trigger an adaptive management action.

M2-5: Based on principles of landscape ecology and ecological restoration, and consistent with Corps planning guidance, the Nearshore Study has identified principles for nearshore restoration that support a process-based approach. Process-based restoration is distinguished from species-based restoration, which aims to improve habitat conditions for a single species or group of species. Nearshore Study objectives seek to benefit the entire ecosystem, with associated improvements in the delivery of broader ecosystem functions and qualities. While increasing salmon populations is one goal of the study, the Corps is recommending actions that broadly support or restore the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., salmon production, bivalve production, and clean water).

M2-6: See Master Response 3.

M2-7: The objective of Civil Works ecosystem restoration is to restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition (not necessarily pre-settlement or historical conditions).

M2-8: See response to Comment M2-5. While increasing salmon populations is one goal of the study, the Corps is recommending actions that broadly support or restore the dynamic processes that generate and sustain desirable nearshore ecosystem structure (e.g., eelgrass beds) and functions (e.g., salmon production, bivalve production, and clean water).

7.3 Comment Letter M3 – Allan Giffen, City of Everett



PLANNING AND COMMUNITY DEVELOPMENT

Allan Giffen
Director

November 18, 2014

Attn: Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755, Seattle, WA. 98124

Re: Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report and Environmental Impact Statement

Dear Ms. Gleason,

In 2009 the City of Everett adopted the Marshland Subarea Plan that included a conceptual plan for future restoration, land use and infrastructure opportunities. The Marshland's location is ideal for tidally-influenced wetland restoration and represents one of the last opportunities for large scale restoration of this type along the mainstem of the Snohomish River in the estuary. Restoration of the Marshland area is also included in the Snohomish Basin Salmon Conservation Plan.

The current PSNERP proposal includes a conceptual restoration plan that is more expansive than in the City's plan. In Everett's Subarea Plan, the City committed to working with willing property owners, and to completing a large number of studies to ensure that any restoration proposed in the area was technically feasible and would not harm property owners who do not want to be included in a restoration project. It also made clear that property owners could change their willingness to participate over time, as this was a long-term planning process. The City continues to commit to meeting those requirements, and is pleased that the PSNERP proposal also commits to working with willing property owners and completing additional technical studies as part of the design process. M3-1

The City of Everett supports inclusion of the Marshland restoration in PSNERP's proposal. Although we do not currently have funding set aside for the project, we hope that can be achieved in the future.

Sincerely,

Allan Giffen
Director

CITY OF EVERETT • 2930 Wetmore Avenue, Suite 8-A • Everett, WA 98201 • (425) 257-8731 • Fax (425) 257-8742

7.3.1 Response to Comment Letter M3

M3-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the City of Everett, Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer coordination in the future.

7.4 Comment Letter M4 – George Boggs, Whatcom Conservation District

Whatcom Conservation District
6975 Hannegan Road, Lynden, WA 98264 Phone: (360) 354-2035 x 5 Fax: (360) 354-4678
e-mail: wcd@whatcomcd.org

November 19, 2014

Via Email
Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755, Seattle, WA, 98124

Re: Puget Sound Nearshore Ecosystem Restoration Project Draft Feasibility Report and Environmental Impact Statement. -- Nooksack Delta Project

Dear Nancy C. Gleason:

In the next 50 years farmers will have to produce as much food as they have done in the previous 10,000 years to meet the needs of the world's burgeoning population. Whatcom is the seventh leading agricultural producing county in the State. These lands provide food, fiber, raw materials, energy and contribute greatly to our local economy. Having said this, the Whatcom Conservation District recognizes that agricultural land presents the greatest opportunities for enhancing fish and wildlife habitat and critical hydrologic processes. Our District supports projects that advance local priorities and deliver these essential functions and values so long as the loss of farmland is fully mitigated. The above referenced project should not go forward absent a con-current commitment to purchase development rights on prime farmland to offset any erosion of our County's farmland base. To do otherwise would not only violate the Washington State Growth Management Act but also the Whatcom County Comprehensive Plan. The Corp's best chance of a successful project would be to propose one that accommodates both local habitat priorities and farmland protection policies. M4-1

Sincerely yours,
Joe Heller, Chair

Board of Supervisors: Joseph Heller Larry Helm Larry Davis Daniel Heeringa Richard Yoder

7.4.1 Responses to Comment Letter M4

M4-1: See Master Response 3. The Corps will continue to coordinate with Whatcom County, the Whatcom Conservation District, landowners, and key stakeholders as project designs for the Nooksack River Delta are refined.

7.5 Comment Letter M5 – Ann Russell

Attn: Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755, Seattle, WA, 98124

11/21/2014

RE: Comments for the Public Record
National Environmental Policy Act
Environmental Review of 2014 Project List
Puget Sound Nearshore Ecosystem Restoration Project (PSNRP)
Nooksack River Delta Project

The WRIA 1 Environmental Advocates Caucus is a collaboration of environmental organizations and individual activists that was organized initially to be a Stakeholder Group in the WRIA 1 Watershed Planning process. This process was initiated by state law to provide for a collaborative approach to the crises of water quantity and quality.

As part of our mandate to provide a voice for environmental values in the WRIA 1 Planning Process, we also find it pertinent to comment on a project planning and funding process in the Nooksack River Delta that has the potential to provide a tremendous positive impact to both nearshore water quality and wetlands habitat, but also to associated dependent biota.

On this basis, we would like to introduce these recommendations into the Public Record in this SEPA Process. We understand that the proposed project phase will encompass feasibility review and initial design.

1. We support, on principle, the restoration of lower Nooksack watershed freshwater wetlands and salt marsh habitats. These habitats were destroyed en masse by earlier "Reclamation" efforts and their loss has been shown to be highly detrimental to the restoration of ESA listed salmon stocks and to the web of life that supports not only fish, birds, insects and plants but our very life on this planet. — M5-1
2. The project could provide considerable public safety benefits by limiting flooding in the community of Marietta on the Lower Nooksack left bank distributaries. — M5-1
3. Water quality parameters for the Lummi River Reconnection should be thoroughly evaluated in light of current pollution of Bellingham Bay and Portage Bay by river borne pollutants. — M5-1
4. Lower summer low flows into Bellingham Bay in light of a Lummi River Reconnection should be examined in the context of lower dilution of current Bellingham Bay pollution and in the context of probable additional pollution to Bellingham Bay from the outcomes of the Bellingham Bay Redevelopment Project. — M5-2
5. Water quantity parameters of any proposed Lummi River Reconnection should consider impacts of diminished summer lower flows into Bellingham Bay on fish migration and sedimentation dynamics. — M5-2
6. Scientific data indicates that similar projects such as the restoration of the Nisqually River Delta wetlands significantly improved the habitat and water quality of Puget Sound and its estuaries. This water quality dynamic should be consider as a potential justification for proceeding promptly with the Nooksack River Delta's restoration. — M5-3
7. Restoration of wetlands on farmlands should be conducted in a manner that is supportive of Whatcom County's agricultural industry and the County's No Net Loss of Farmland policy. One associate concept is that farmlands loss mitigation from the project could go into purchasing Development Rights on prime farmlands currently threatened with potential development. — M5-4

There are various other environmental opportunities and challenges not enumerated in this letter and we ask you to be true to your mandate as The Environmental Protection Agency to require that this project will provide the highest environmental return with the minimal damage to environmental values.

Environmental Caucus Members*:

Jim Hansen
Ann Russell
Bert Webber
Brooks Anderson
Gaythia Weis
Joe Knight
John Bremer
Marian Beddill
Pam Borso
Wendy Steffensen

*The views in this letter are those of individuals, and not that of the affiliated organizations of the Environmental Caucus

7.5.1 Responses to Comment Letter M5

M5-1: Comments noted.

M5-2: A water quality evaluation will be completed during the Pre-Construction, Engineering, and Design Phase. Water quality parameters as well as summer low flows will be evaluated as project designs are refined.

M5-3: Comment noted.

M5-4: See Master Response 3.

7.6 Comment Letter M6 – Roylene Rides-At-The-Door, Natural Resources Conservation Service

USDA
United States Department of Agriculture

November 21, 2014

Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, Washington 98124-3755

RE: Comments to the Draft Feasibility Report, Environmental Impact Statement – Puget Sound Near Shore Restoration Study

Dear Ms. Gleason:

The Natural Resources Conservation Service (NRCS) has funded a flood control project and is an easement holder for many of the identified in the Draft Feasibility Report, Environmental Impact Statement for the Puget Sound Near Shore Restoration Study. It is important that the USACE and WDFW fully understand the scope and extent of our holdings and investments as they may negatively impact the goals and objective set forth in the Study.

Marshland Flood Control District

The NRCS has contributed significant technical and financial investment in the flood control facilities within the proposed Everett Marshland Tidal Wetland Restoration plan. We are happy to provide the background information surrounding the flood control system. The Marshland Flood Control District (MFCD) has entered into a legally binding operation and maintenance agreement with NRCS for all of the works of improvement including the Pump Plant, Floodway Channel and Dike system. Based on our review, all of the flood control facilities will be impacted by the proposed restoration activities. The operation and maintenance agreement that NRCS has with the MFCD would prevent any modifications to the existing flood control measures.

Drainage and Flood Control Infrastructure History

The drainage and dike construction work in the 1950s and 1960s was a common practice to establish farmable acres. These practices were utilized because they supported the goals to establish stable food production resources. With further advances in equipment and farming practices after WWII, increasing farmable acres was just one of the solutions to increase food production. M6-1

The drainage and flood control infrastructure installed with the assistance of the NRCS, formerly the Soil Conservation Service, in the Marshland area are extensive. The NRCS technical and financial investment in the proposed project area has been substantial. Information presented in the Draft EIS outlines alternatives which include the removal of the existing flood control structures, rebuilding dikes, pump station and tide gates within the Everett Marshland study area. The proposed alternative will directly affect the flood control facilities funded by NRCS and the overall objectives outlined in the NRCS Marshland Watershed Plan approved in 1959. Over the past 49 years, the federal government has made a significant investment to provide drainage systems and flood water protection for the farmable ground within the Marshland floodplain. MFCD and NRCS have entered into a binding Operation and Maintenance (O&M) agreement that obligates MFCD to operate and maintain all of the flood control facilities. Undoubtedly this will need to be considered as each alternative is evaluated. The O&M agreement will affect the implementation of the Subarea plan as proposed.

Natural Resources Conservation Service
316 W. Boone Avenue, Suite 450 Spokane, Washington 99201-2348
Voice (509) 323-2900 Fax (855) 847-5492
An Equal Opportunity Provider and Employer

NRCS in Washington State recognizes the importance of wetland restoration and the hydrologic connections between freshwater and saltwater tidal streams as vital for salmon habitat. The natural hydrologic resources in the Marshland Subarea area definitely lend themselves toward this type of wetland restoration. Seasonal high groundwater, precipitation and the freshwater and saltwater connectivity are all existing hydrologic features at this location.

NRCS is providing the following comments to the "**Draft Feasibility Report, Environmental Impact Statement – Puget Sound Near Shore Restoration Study**" for consideration in the finalization of the report.

Comments:

1. Current Operation and Maintenance (O&M) Agreement - MFCD and NRCS have entered into an O&M agreement for all of the facilities that NRCS provided financial assistance. Funding for construction of the flood control facilitates was provided by the PL-566 Small Watershed Protection program. NRCS is responsible for implementing and carrying out the program requirements.

    a. Facilities within the Subarea plan boundary that were financed by NRCS include; Pumping Plant, Floodway Channel and Dike system. The O&M agreement requires the MFCD to operate and maintain the facilities. Failure of the MFCD to operate and maintain the facilities in accordance with the O&M agreement could result in federal action to recover past financial expenditures for flood control facilities.

    b. PL-566 program provisions are provided for decommissioning elements of financed watershed projects, however there must be compelling and justifiable rational for doing so. Any proposed action would need to have the full support of our project sponsor. M6-1

2. Complexity of project - NRCS has provided technical assistance since the mid-1950s to design and install the MFCD pump station, tide gate and dike. The technical challenges to design stable structural measures in this area have proven very difficult. The following should be considered:

    a. Overcoming geotechnical issues to construct a new pumping plant will require significant site investigation and planning. Peat and organic soils are prevalent within the proposed relocated pumping plant site. It should be anticipated that stabilization of the foundation or installation of piles will be required in order to provide a stable foundation for the relocated pumping plant. The estimated cost of construction could be much higher than the estimate contained in the Subarea Plan. In order to better anticipate the project cost of the pumping plant, it is recommended to complete a planning level geotechnical investigation to verify technical feasibility from which to base the cost estimate.

    b. Constructing a new dike system will pose various challenges. The foundation soil may not be adequate to construct a dike at the proposed location. Extensive settlement should be anticipated, weak bearing soils, and a high likelihood of piping prone soils should be anticipated; all of which will require treatment measures in order to mitigate the detrimental effects to the proposed flood control facilities. In order to better anticipate the project cost of the dike, it is recommended to complete a planning level geotechnical investigation to verify technical feasibility from which to base the cost estimate.

    c. The hydraulic analysis will be quite challenging for flow regime design purposes and limiting adjacent property negative impacts. The proposed wetland restoration project will certainly affect the Snohomish River hydraulics. A coordinated dike agreement was developed in 1991. The purpose of the agreement was to establish enforceable dike elevations for flood control dike districts on both sides of the Snohomish River. The hydraulic model will need to be revised to include the topographical changes as proposed in the preferred Subarea Plan.

Any changes to the water surface profile and potential dike height modification will need to be agreed upon by all impacted flood control districts. It is recommended to include all costs related to the revised analysis and updated coordinated dike agreement into the Subarea plan.

d. The proposed wetland restoration project will certainly affect the surface and ground water hydrology within the proposed Subarea plan. Seepage through and under the relocated dike should be a consideration. It is our opinion that a dramatic change in the ground water hydrology will occur. The area within the Subarea plan will become affected by the daily tides which could cause seepage areas into areas along the dike that are intended to be excluded from changes to ground water hydrology. It is recommended to evaluate and estimate the potential impacts to the areas outside of the Subarea Plan dike system, and to propose mitigation measure to prevent ground water from having detrimental impact outside of the Subarea Plan.

e. Topography of the valley floodplain along the lower Snohomish river valley typically slopes away from the riverbank. Relocation of the pumping plant and dike will present difficulties. It should be anticipated the dike elevation will be significantly higher measured from the existing ground line to the top of the dike as the floodway channel is approached. The increased hydrostatic pressure will increase the complexity of designing and constructing a stable dike and pumping plant. While the Everett Marshland Tidal Restoration plan identifies a preferred alternative, technical feasibility has not been demonstrated. In order to better anticipate the overall project cost, it is recommended to complete a planning level geotechnical investigation to verify technical feasibility from which to base the cost estimate.

3. Cultural Resources - Wetland restoration activities typically occur in lowland valley areas where the likelihood of past human use is high. M6-1

   a. NRCS recommends expanding the cultural resources section to clearly identify the potential impacts to known and likely cultural resources within the proposed Subarea Plan. A literature review provides limited data. It is recommended to conduct a surface reconnaissance to better determine potential cultural resource impacts and proposed mitigation measures.

   b. The cultural resource impacts and considerations should include both pre and post European settlement of the proposed project area.

   c. It should be anticipated that significant time and money will be needed during the planning stage before any work can begin. This cost should be reflected in the overall project cost for each alternative developed.

4. Planning and Project cost - Without adequate planning, the preferred alternative could fail on any number of levels. Legal and regulatory issues will need to be addressed. The actual on the ground construction cost of this type of project is often a fraction of the overall project cost.

   a. Planning and design of the preferred option will be an additional expense to the actual installation costs and should be estimated and included in the Subarea Plan.

   b. Due to the location of the project, number of landowners affected, the wider public interest and the City of Everett; thorough planning will be vital to ensure success.

   c. Hydrologic patterns and anticipated water table changes will need to be considered and mitigated through properly designed flood control and drainage structures.

   d. The human element of planning, from landowners to citizens is one of the most difficult to anticipate. It is vital that a majority of the participants support this project. The public will need to understand the environmental benefits of this project and environmental education may need to be included in the planning.

5. Maximum Restoration - Wetland areas are dynamic systems and their restoration is vital to a multitude of species.

   a. These types of projects require a large investment of time and money; it is suggested to maximize the environmental benefits for the dollars invested. The chance to restore a significant amount of wetland and establish tidal connectivity is a tremendous opportunity to improve our natural resources.

   b. If the Marshland Subarea Plan is implemented, it is recommended that the maximum restoration be pursued within the anticipated constraints surrounding the chosen alternative.

NRCS Easement Programs

The NRCS has several permanent conservation easements within the Puget Sound Near Shore Restoration Study area. There are three programs involved; the Farm and Ranchland Protection Program (FRPP), Wetland Reserve Program (WRP) and Emergency Watershed Program-Flood Plain Easements (EWP-FPE). These are permanent easements that either restrict land uses to those that are compatible with long-term agricultural production (FRPP) or control all rights to the use of the land with limited interests (including fee title) reserved to the landowner (WRP and EWP-FPE) and have their primary purpose being wetland and floodplain protection and restoration.

M6-1

There is no legal authority to "buy back" these easements or alter the terms and conditions of the easement deeds. There is very limited authority to adjust easement boundaries where there is a compelling public interest and where there is no other practical alternative. In all cases, the terms and conditions of the easement deed will dictate what types of activities and land uses may be allowed for the subject property.

The WRP and EWP-FPE easements may ultimately be compatible with the proposed actions. Each individual case will need to be evaluated to determine if there is an adverse effect on the terms and conditions of the easement deed.

There is a serious concern with the proposed actions and the FRPP easements. These easements restrict the landowner from doing anything (or allowing to be done) that will adversely affect the long-term agricultural use of the land under easement. These easements are primarily held by third party land trusts with the federal government reserving the right to enforce the deed in the event the land trust cannot or does not. If a proposed action will alter the ability to use the land under an FRPP easement for agricultural production, the landowner, land trust and the NRCS will have to oppose it. Each individual project will need be evaluated to see if there are any NRCS program easements on potentially affected properties.

NRCS appreciates the opportunity to comment on the draft study and we hope our comments are helpful.

Best Regards,

ROYLENE RIDES-AT-THE-DOOR
State Conservationist

cc: Rick Noble, Area Conservationist, NRCS, Olympia
Larry Johnson, State Conservation Engineer, NRCS, Spokane
Bonda Habets, State Resource Conservationist, NRCS, Spokane
Jeff Harlow, Assistant State Conservationist for Programs, NRCS, Spokane
Tony Sunsen, District Conservationist, NRCS, Mt. Vernon
Amy Hendershot, District Conservationist, NRCS, Puyallup

7.6.1 Response to Comment Letter M6

M6-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the NRCS, City of Everett, Marshland Flood Control District, landowners, and other key stakeholders will be notified to

ensure closer coordination in the future. The comments provided by NRCS will be considered if and when this project is carried forward in the future.

7.7 Comment Letter M7 – Bill Schmidt, Skagit County Farm Bureau



The Voice of Agriculture
P.O. Box 573
Clearlake, WA 98235

November 21, 2014

Dear managers of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP),

This letter is to document that the Skagit County Farm Bureau opposes the project and requests an extension of time be added to the comment period. It is incomprehensible that several agencies can take over ten years to present a proposal and expect constructive comments within 30 days. M7-1

We have seen past projects overlaid with new proposals that negate any benefits gained, increase costs, decrease the agricultural land base and never deal with the true most limiting factors. We have also witnessed past projects that simply have not worked and decreased benefits compared to the pre-existing state of being. M7-2

Sincerely,

William Schmidt

Skagit County Farm Bureau President

7.7.1 Responses to Comment Letter M7

M7-1: The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days, ending on January 8, 2015.

M7-2: Comment noted.

7.8 Comment Letter M8 - Peter Landry

Peter Landry, P.E., L.E.G
5825 South 2nd Ave.
Everett, WA 98208

Nov 21st, 2014

To: US Army Corp of Engineers, Attn: Nancy Gleason
CENWS-E-ER
PO Box 3755
Seattle, WA 98124

Regarding: Marshland Tidal Restoration Project included in PSNERP

I am writing and speaking to forcefully oppose the PSNERP restoration project proposal for the west bank of the Snohomish River, from roughly the southern City Limits of Everett north to the neighborhood of Lowell, in Everett. I live in the project are and the whole of my property has been identified as a necessary property for the project. I own property from about 4 feet above sea level, up to about 45 feet above sea-level. I am a civil engineer licensed in Washington State, and I am also a licensed engineering geologist in the State of Washington. I was a Marine Science Technician with the US Coast Guard from 1999-2007, and certified as a CG Pollution Investigator. I am also a scuba diver that was licensed to dive in the Puget Sound at the age of fifteen. I currently participate in Shoreline Processes lectures with the Conservation District program. I speak as a resident, and an expert in fluvial/coastal engineering, and geology, and as a landowner which would be required to sell my property to the government to allow this project to occur. I WILL NEVER VOLUNTARILY SELL THIS PROPERTY TO THE GOVERNMENT. However I have discussed an idea to give the City of Everett one acre of my property as a part of a "Hundred Acre Wood" forest park, which as some support with my neighbors.

I only became aware of this project because I was a Public Works Director at Normandy Park, where the Beaconsfield Project, another PSNERP project was proposed. As only government staff, politicians, and environmental interests are involved in the PSNERP process, I just saw it on the PSNERP documents, when I reviewed them as a CITY OFFICIAL. I found this project out in 2011, and I met with WDFW staff then, told them about the NRCS letter to City of Everett and the serious challenges of cross-valley dikes etc. PSNERP staff have set about this program with great biases, and did not do any reasonable pro-con review of these projects even on a simple prima fascia basis, and I think with little consideration but their own employment. M8-1

Here are my main forceful negative comments:

- No landowner involvement in conceptual plan.
- Is not compatible with 5 year old Everett Subarea Plan, which went through public process.
- Does not respect the community, nor the well over 100 years of farming tradition.
- Would destroy the largest riparian forest of approx 100 acres on the West bank of the lower Snohomish River which is a forested wetland with mature evergreens of well over on hundred feet.
- Would require the government buy-out of approximately a dozen residences, and loss of numerous farming and livestock enterprises. It doesn't value community agriculture, esp. small scale.
- Would require between a third to a half of a BILLION DOLLARS to build
- Would make the Government responsible for the new railroad bridge, and if subsidence occurs (which it likely will), ongoing government funding for a railroad that currently is entirely the responsibility of Burlington Northern.
- Ignores, or was prepared with ignorance of, the detailed NRCS letter about the poor soils in the area for diking, the difficulties the NRCS had in construction the current system in the 1970's, likely higher than normal costs to build in the area.
- Spent untold tens of thousands of dollars preparing a plan, with no preceding studies, even of secondary review of NRCS records.
- No discussion of flooding consequences wit the City, FEMA, and concerned and affected residents.
- Burden of impacts for the entire PSNERP program is based on avoiding high value properties and dense communities on the ACTUAL PUGET SOUND because that is too hard, and would involve many wealthy shoreline landowners, so the program focused on poorer area with low land values.

I will now challenge the Ecosystem Restoration Benefits of the Marshland Project.

Stated Project Benefits by PSNERP Staff	**Challenge to PSNERP Statement & Likely Negative Environmental Impacts**
* Restore productive tidal freshwater wetland habitat that support biodiversity and provide Connectivity between land and sea.	* *Flooded area will likely be a huge reed canary grass monoculture, with far less biodiversity after loss of 100 acre mature forested wetland. which is located at elevations of 6-8 ft which would daily experience inundation and die.*
* Restore large river delta that provides Valuable nursery habitat for juvenile Salmon, increasing survival, and supporting Puget Sound population recovery.	* *Marshland subarea is not a "delta" it is an "upper delta plain" which is "indistinguishable from the lower part of a fluvial valley" (Brenner et al. (1988) *1. Far from the Bay, with no saltwater influence Flooded areas will likely be dominated by matted reed canary grass. These environs tend to have low dissolved oxygen which limits salmonid use.*
* Improve Estuary Water Quality.	* *The proposed Marshland project will have almost NO effect on Water Quality. Poor water quality in the canal is due primarily to dairies and commercial agriculture far up valley. The low intensity farming in the planned flooded "restored" area has no dairies, nor any large livestock herd. The statement the project will have any significant effect on water quality downstream is a clear misrepresentation of the projects results.*
* Increase shoreline area, length, and complexity.	* *This statement does not indicate that the Shoreline that is increased is a riverine one. This is NOT Puget Sound. This project does Not have any effect on Puget Sound Shorelines, But it gobbles up a full THIRD of the PSNERP 1.1 BILLION DOLLARS, with a price tag of* $328,000,000.
* Improve resiliency of the shoreline to Respond to changes in environment Rising sea levels, increasing storms.	* *This is a ridiculous stated benefit. Climate change is the single most important environmental challenge of our time. There are thousands of homes at risk from sea-level rise in the next 50 years in Puget Sound NOT ONE HOME IS BENEFITED FROM THIS PROJECT. The River Levees are at 20 feet, That is some 7-8 feet above current high tides. Many communities and shores will be Devastated by 2 feet of sea-level rise, help them.*

M8-1

*1. *from Integrative Stratigraghy (1988) pg 173*

I will now put forth a clear argument against the Marshland Tidal Restoration Project. The main elements are:

1. Failure of due process during selection, ranking, and scoping process, and without inclusion of any affected or nearby landowners as per PSNERP program guidelines or inclusion and consultation with key government entities such as the Marshland Flood Control District, Snohomish County Public Works, or the Federal Emergency Management Administration. PSNERP even ignored their own policies and guidelines which most projects had detailed public outreach efforts. Whether on purpose or oversight, no public involvement means the project did not follow guidelines during selection and therefore selection is biased.

2. Plan does not conform to City of Everett Marshland Subarea Plan. The Marshland Subarea Plan specifically states that "Agricultural uses will continue outside of restoration areas including commercial agriculture, small scale hobby farming, and personal livestock husbandry" It also states recognizes "existing valuable agricultural use". The subarea plan also says, The (Marshland) *sic* "subarea plan provides for a combination of restoration, recreation, agricultural, and residential uses within the subarea." As a "Full Restoration" project does not comply and conform with the fairly recent Marshland Subarea Plan which went through reasonable public process, with both landowner and NRCS, FEMA, Marshland Flood Control District and other government agencies able to provide advice and comment. Also the conceptual plan does not"blend"(ed) restoration "with passive recreation, including open space and trails. (Refer to the included "appendix A" which is page 1 of the Everett Marshland Subarea Plan.) M8-1

3. Neglect of Impact to Important Riparian Forest Habitat, would lead to Destruction of largest mature riparian forest in Lower Main (West Bank) Snohomish River. The rich soils in the Marshland area led to early dike construction approximately 125 years ago, and with protection from frequent inundation, a great forest grew from likely small stunted trees (doomed to early toppling and death) to a grand nearly old growth forest over the last 125 years. This forest is both a home for permanent and transitory and migratory wildlife. The proposal to blindly remove all flood control does not recognize the almost total loss of riparian forest in the several square mile area of and surrounding the Marshland area. This narrow restoration vision does not consider what would be lost with the implementation of a "Full Restoration" which a Full Restoration is the only option ranking high enough to qualify for Inclusion in PSNERP. Inclusion of marshland is based on a Full restoration for ranking even though that is not possible under City of Everett Subarea Plan, has no landowner support; therefore one is to find that it is actually not being included as a viable project based on the criteria of the program. There was no assessment and consideration of the value of habitat that would be threatened by the project.

4. What the heck does flooding farms have to do with Puget Sound Restoration.
During the November 5th open house meeting the Government Staff presenters made a long presentation about the state of Puget Sound, the fact most of Puget Sound has altered and armored shoreline, and the need for removal of bulkheads, and restore Puget Sound Environments. Then the projects were explained, and staff explained the large loss in "Delta" habitat, so many of the project focused on "Deltas". One, While the Marshland is influenced by tidal backwatering of Port Gardener Bay, there is not any saltwater for miles downstream from this project. The Marshland project is 1/3 of the program budget, yet is far from Sound.

5. The Project as conceptualized is not feasible. The project as conceptualized is not feasible because it requires that residents sell their property and leave. Some property owners have homes that are not compatible with this plan as conceived. Other property owners may keep their homes but will lose almost all use of almost all of their property. Aside from that this violates the written intent of the subarea plan, Most land owners will not cooperate with land acquisition. In addition the soils in the Marshland area are very peaty to some depth, and significant technical challenges exist which were not realized at the time of ranking/selection. Also FEMA and Snohomish County Public Works, nor the Marshland Flood Control District were not contacted and consulted as a part of the project scoping and ranking. Such thorough pre-project selection inquiry would have led to staff discovering both FEMA and NRCS letters sent to the City of Everett as a part of the Subarea Plan Process. The conceptual plan has not been examined at all for flood impacts to actual Marshland landowners or even downstream City of Everett areas. (Please see "appendix B" attached which is a 4-page letter from the NRCS concerning dike and flood control structures, difficulty to construct, and poor soils, and recommendation for landowner involvement.) (Please see also "Appendix C which is a simple "flood and drain" analysis showing simple flap gates will not adequately serve the lower Marshland community if the pump station is removed, remember the Marshland subarea plan promises any restoration project will maintain or improve both flood control and drainage system function including post-flood draining and recovery for private landowners in the subarea)

6. Because of the lack of reasonable due process, no outreach to landowners, secret processes designed to block public involvement, and the other process and technical issues mentioned, I, Peter Landry as a key landowner will not cooperate in any way, and in fact am a fervent project opponent, and will work diligently to prevent any restoration project included in PSNERP program from occurring that has these flaws. When I brought up issues years ago I was ignored, and staff has ignored my protests of un-American violations of due process. As a strong environmentalist, I am devastated that the solution to save Puget Sound you guys have decided on, requiring a third of a Billion Dollars has nothing to do with actual Puget Sound, but is to foolishly plan to flood my farming community 10 miles from the salt water. As an environmental professional of some 20 years, it is my finding significant research shows that mosaics of mature natural forests, wetlands, and areas of managed disturbance such as farm fields have higher biodiversity than " so called" restored areas. In Japan areas of wetland, farm forest mosaics are called "Satoyama" and have very high biodiversity, higher than in pure wetland or forest environments alone. This is something you should consider when considering GIANT restoration plans.

M8-1

You should have discussed your ideas with the landowners BEFORE you drew up a plan to get rid of the residents, and the 100 acre wood and its wildlife, and countless people's enjoyment and use of this area. How would you like it if someone from the government put a target on your property and a place you love and said "We think we should do this!, and it means you will need to sell your property to us, and were gonna flood it and who cares about you, or the forest, or community, or the $$$$$" Shame on you, you incomprehensibly stupid, wasteful, and inconsiderate Bureaucrats!

Sincerely,



Peter Landry, Professional Civil Engineer, Professional Geologist, USCG (Hon Dis)

Other public comment materials received held by Corps office, but not included here:

- Appendix A: Introduction to the Everett Marshland Subarea Plan, n.d.
- Appendix B: NRCS comments on the City of Everett Marshland Subarea Plan, in a letter to the City of Everett, dated 12/12/2008
- Appendix C: Snohomish County Stream Gage data at Ebey Slough, dated 11/2006
- Qualifications of Commenter
- Public Records printout re: Everett Marshland project, dated 2010

7.8.1 Response to Comment Letter M8

M8-1: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the City of Everett, Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer coordination in the future. The comments provided in your letter will be considered if and when this project is carried forward in the future.

7.9 Comment Letter M9 – Brent Carson, on behalf of the Hadley-Colmenares family

Van Ness Feldman LLP

719 Second Avenue, Suite 1150
Seattle, WA 98104-1728
206-623-9372
vnf.com

November 21, 2014

Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, WA 98124-3755

Re: Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) – Beaconsfield Project

Dear Ms. Gleason:

Please accept these comments on the proposed PSNERP Draft Integrated Feasibility Report and Environmental Impact Statement (the "EIS") prepared by the U.S. Army Corps of Engineers (Army Corps) and Washington Department of Fish and Wildlife (WDFW). We are writing to express our clients' continued and unwavering opposition to inclusion of the "Beaconsfield Feeder Bluff" project (the "Beaconsfield Project") in any future restoration programs, including the PSNERP.

Van Ness Feldman LLP represents the Hadley-Colmenares Family[1], who own the property uphill from and protected by the bulkheads and rock revetments ("Armory") proposed to be removed by the Beaconsfield Project. The Hadley-Colmenares Family legally installed this Armory to protect its property and has legally enforceable easement rights to maintain all of this Armory – not merely that portion of the Armory shown to remain in the EIS.[2] A map and photo showing all of the Hadley-Colmenares Family's Armory are enclosed.

The statement made on page 139 of the EIS that the Hadley-Colmenares Family is a "willing landowner" to the proposed Beaconsfield Project is blatantly false. The Hadley-Colmenares Family has consistently expressed its opposition to removal of any of its Armory

[1] The Hadley-Colmenares Family and its ownership interests in the vicinity of the Beaconsfield Project are as follows: Lisa A. Colmenares owns King County Tax Parcel No. 0622049031; Lisa A. Colmenares and Angel I. Colmenares own King County Tax Parcel No. 0617000095; Robert M. Hadley and Poseidon Investment Company own King County Tax Parcel No. 0617000096; and Robert M. Hadley owns King County Tax Parcel No. 0722049002.

[2] The easements legally protecting the rights of the Hadley-Colmenares Family include, but are not limited to, recorded easements identified by the following King County Auditor File Numbers: 4176420; 4097062; 4064809; 4125038; 4117080; 4064808; 4122785; 4110705; 4114543; 20130805002016; 20130805002042; and 20141015000323.

38034-6

due to the risks to its property and the risks to life safety. They are unwilling to grant any rights to the Army Corps, WDFW, the City of Normandy Park, or any other agency or organization for such activities. The Hadley-Colmenares Family will not allow its Armory to be removed.

WDFW may recall from previous communication[3] that the Hadley-Colmenares Family sued both the City of Normandy Park (the "City") and Forterra when efforts by both were started to fund and implement the Beaconsfield Project and the removal of the Armory. *See* King County Superior Court Cause No. 11-2-2-862-1 KNT. That lawsuit was ultimately settled in a legally binding Settlement Agreement among the members of the Hadley-Colmenares Family, the City, Forterra and the Washington State Recreation and Conservation Office. A copy of that Settlement Agreement is attached.

In the Settlement Agreement, the City recognized the Hadley-Colmenares Family's easement rights to maintain and repair the Armory now and in the future. Further, the City agreed to eliminate removal of the Armory as an element of any future restoration work at Beaconsfield unless the Hadley-Colmenares Family provided express written consent. The Hadley-Colmenares Family has never provided such consent and, in fact, has consistently maintained its opposition to removal of its Armory. Given the clear and unwavering position of the Hadley-Colmenares Family, and the express terms of the Settlement Agreement, the Army Corps should not misconstrue the October 7, 2014 letter that the Corps received from the City[4] as supporting removal of the Armory, as any such support would be inconsistent with the City's obligations under the Settlement Agreement.

M9-1

My clients are deeply concerned that the Beaconsfield Project, with its proposed removal of the Armory, continues to be suggested by any agency and that misrepresentations continue to be made that the Hadley-Colmenares Family are "willing landowners."

M9-1

The Hadley-Colmenares Family retained GeoEngineers in 2011 to review the plans then proposed by the City and Forterra to remove the Armory. A copy of that report is enclosed. Among its conclusions is the following:

> *The "science" that has been employed to evaluate the Beaconsfield project feasibility is flawed and is slanted toward a solution (bulkhead removal) that will not produce tangible benefits to nearshore ecology. The studies of the existing conditions of the Hadley home and the impact to the Hadley properties from bulkhead removal are likewise flawed.*

In particular, GeoEngineers found that the volume of sediment that is prevented by the Armory is "tiny" (estimated at 530 cubic yards if all Armory was removed) in comparison to the more than one million cubic yards of sediment that currently exists in the shoreline deltas of Des Moines Creek, Normandy Creek and Miller Creek located within this drift cell.

The Hadley-Colmenares Family supports legal and cost-effective efforts to restore the Puget Sound. The Beaconsfield Project meets neither criterion.

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[3] See June 14, 2011 Letter to Phil Anderson, Director, WDFW (enclosed).

[4] See October 7, 2014 Letter from City of Normandy Park, Environmental Committee to Colonel John Buck (enclosed

58334.6

The Army Corps and WDFW should remove the Beaconsfield Project from inclusion in the PSNERP and any future restoration proposals. M9-1

Very Truly Yours,

Van Ness Feldman, LLP

Brent Carson

Enclosures

cc: Theresa Mitchell, Washington Department of Fish and Wildlife
Glenn Akramoff, City of Normandy Park
Client

Other public comment materials received held by Corps office, but not included here:

- King County parcel map of Hadley-Colmenares property, dated 11/20/2014
- Photograph/diagram of shoreline armoring locations along property shoreline, dated 1/18/2013
- Letter from Brent Carson to Phil Anderson (WDFW) re: Beaconsfield on the Sound Project, dated 6/14/2011
- Settlement Agreement, dated 8/21/2012
- Letter from City of Normandy Park to U.S. Army Corps of Engineers re: PSNRP Letter of Support, dated 10/7/2014
- GeoEngineers Technical Review and Assessment, Beaconsfield Bluff Bulkhead Removal Project, dated 6/16/2011

7.9.1 Response to Comment Letter M9

M9-1: See Master Response 1. The Beaconsfield project is no longer included in the recommended plan.

7.10 Comment Letter M10 – Shari Tarantino, Orca Conservancy

November 23, 2014

Sent electronically: nearshore@usace.army.mil

U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, WA 98124-3755
Attn: Nancy C. Gleason

Orca Conservancy hereby submits the following comment in support of the tentative proposal to restore more than 5,000 acres of central and northern Puget Sound shoreline habitat – the Puget Sound Nearshore Ecosystem Restoration Project

Orca Conservancy is an all-volunteer 501(c)(3) Washington State non-profit organization working on behalf of Orcinus orca, the killer whale, and protecting the wild places on which it depends. The organization's urgent attention is on the endangered Southern Resident orcas of Puget Sound. These three pods – J-Pod, K-Pod and L-Pod – were decimated by the depletion of prey resources, the accumulation of marine toxins, and the destruction of salmon spawning and nearshore habitats, the nurseries of the Salish Sea.

Southern Resident killer whales are listed as endangered under both the **U.S. Endangered Species Act (ESA)** and **Canada's Species at Risk Act (SARA)**. New scientific information and analyses about the Southern Resident population and the extent of their reliance on salmon – particularly large Chinook salmon – strongly suggest that Chinook abundance is very important to survival and recovery of the Southern Residents. (NOAA Fisheries, Nov. 2014/http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/effects_fisheries.html). A key physical feature of the southern resident killer whale's critical habitat is that these areas by virtue of their underwater topography funnel salmon into areas where they concentrate before spawning. M10-1

The widespread loss of estuarine and nearshore habitats throughout Puget Sound comes at a price. Puget Sound Chinook salmon are just one of many species whose populations have declined to precariously low levels (ESA endangered status) due to a variety of perturbations, including estuarine and coastal development. Juvenile fall Chinook salmon utilize a number of habitats during their migration to the open ocean. One important habitat is the estuary, particularly tidal deltas, which provide a migratory corridor, protection from predators, and opportunity to forage, grow and adapt to seawater. (Beamer, E., A. McBride, C. Greene, R. Henderson, G. Hood, K. Wolf, K. Larsen, C. Rice, and K. Fresh. 2005. Delta and nearshore restoration for the recovery of wild Skagit River Chinook salmon: linking estuary restoration to wild Chinook salmon populations. Supplement to: Skagit Chinook Recovery Plan, 94 p). Herring and other forage fish are an important prey resource for Chinook salmon and ESA listed marbled murrelets.

Puget Sound has 19 Pacific herring stocks; the populations from all have decreased since 2002. The largest decreases are found in the north Puget Sound area; where said stocks dropped from roughly 12,000 tons of

Orca Conservancy , P.O. Box 19897 , Seattle, WA 98109 , email: orcaconservancy@gmail.com

spawning biomass to 4,000 tons in 2004. (Puget Sound Update: Ninth Report of the Puget Sound Ambient Monitoring Program, Puget Sound Action Team, 2007). Pacific Herring are a vital component of the marine ecosystem, and are a key indicator of the overall health of Puget Sound. Healthy stocks of herring would indicate that the food web in Puget Sound is functioning to provide a prey base for fish, seabirds, and marine mammals; that nearshore and open-water habitats are functioning properly; and that fisheries for bait and other products are available for Puget Sound residents. (The Puget Sound Partnership, Action Agenda, 2011).

The habitats forage fish, salmon, and killer whales depend upon have been degraded by both biological and chemical contaminants, and physical damage. The proposed restoration would play a role in mitigating habitat damage from stormwater runoff contaminated with toxic chemicals and pathogens. Industrial activities such as construction, drilling, pile driving; pipe laying and dredging are the most likely sources of physical damage to critical habitat. Shoreline armoring has a strong negative impact on forage fish. Flood control structures negatively impact salmon. Physical structures such as wharves and net pens for aquaculture may displace killer whales. Both the placement of individual structures and the cumulative effect of multiple structures should be assessed against the needs of killer whales in critical habitat. The proposed restoration effort should significantly improve habitat quality for man species of concern. M10-1

Lastly, Puget Sound, the second-largest estuary in the United States, is a Pacific Northwest icon. The nearshore habitats are the most productive parts of the Sound -- improved understanding of it is vital to restoration and preservation of the entire Sound. Please revise the draft statement, and submit to Congress, as planned, in the fall of 2015.

Sincerely,



Shari Tarantino
President, Board of Directors,
Orca Conservancy
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Facebook: https://www.facebook.com/OrcaConservancy
Twitter: https://twitter.com/OrcaConservancy
Blog: http://orcaconservancy.wordpress.com/

7.10.1 Response to Comment Letter M10

M10-1: Thank you for your comment. The Corps will continue to evaluate restoration opportunities across the Puget Sound nearshore. The Final Feasibility Report and Environmental Impact Statement highlights the importance of nearshore restoration to improve habitats for the species you listed in your letter including the Southern Resident killer whale.

7.11 Comment Letter M11 – Gary Brandstetter, Marshland Flood Control District

MARSHLAND FLOOD CONTROL DISTRICT

P.O. Box 85 • Snohomish, Washington 98291-0085 • Tele (360) 568-6044 • Fax (360) 568-3785

Sponsoring **MARSHLAND WATERSHED PROJECT**

November 24, 2014

Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, Washington 98124-3755

Re: PSNERP; Everett Marshland

Dear Ms. Gleason:

Marshland Flood Control District (MFCD) has already submitted a letter dated November 5, 2014 at your November 5, 2014 Public Meeting in Burlington. Please refer to that letter regarding what and who MFCD is; namely, a statutory special purpose district in the State of Washington with three (3) elected officials.

MFCD appreciates that Theresa Mitchell of Washington State Department of Fish and Wildlife (DFW) advised on 11/21/14 that the comment period "has been extended to January 8, 2014" (sic 2015). Nevertheless, MFCD requests that the 45 day comment period (10/10/14 to 11/24/14) be extended at least six (6) months. For one thing, MFCD did not receive its first direct notice of this proposal until an email arrived on 10/13/14, 3 days after the 45 day comment period had already begun. Second, the email only contained a map with 11 dots, one of which was marked "Everett Marshland" with no specific information. Third, MFCD only received more specific information when an NRCS engineer, who had examined web links, called on 10/15/14 to advise that some specifics were available and then forwarded those specifics by email. Fourth, MFCD then forwarded that email to Snohomish County where the head of Public Works said he and his staff knew nothing about this proposal even though it specifically calls for the "removal" of a major County arterial. Likewise, an MFCD member, when he became aware of it, brought it up at a Sustainable Land Strategies (SLS) meeting and was told by members of the Tulalip Tribes that they knew nothing about it. M11-1

Under these circumstances, the list of alleged "News Releases By Month" in your 10/8/14 posting – not sent to MFCD until 10/13/14 – has obviously not been effective, worthwhile or adequate notice. Also, extending the comment during the holiday season, is not conducive to informed comment. Property owners whose land is included in a government proposal cannot drop everything else they are doing just to comment on information they should have heard about directly and individually months, if not years ago. Likewise, governmental bodies like Snohomish County and MFCD, which represent those property owners and are also affected – adversely – by the proposal should have received direct and specific notice. It is NOT an appropriate response to say that "Well, we're asking for your input now (allegedly) 10 years down the line."

November 24, 2014
Page 2

Beyond the request for a six (6) month comment extension, MFCD requests that face to face public meetings between Army Corps and DF&W personnel be scheduled with MFCD and its directly affected members.

As far as comments within the previous limited 11/24/14 time frame MFCD offers the following:

1) 829 acres is over 13% of MFCD's acreage which pays $30/acre for operation. A loss of 13% of operating revenues would have a substantial detrimental effect.

2) The area proposed is far larger than necessary in order to accomplish even the hoped for beneficial effects for fish habitat. Limiting the proposal to acreage along the most westerly portion of the 829 proposed acres which are directly connected to Woods Creek would avoid any necessity for filling the MFCD flood canal and removal/replacement of the MFCD Pump Station. It would also avoid removal of the Lowell-Snohomish Road, a major County arterial built on top of MFCD's best levee. Both the County Road and Levee were built with federal money from the Federal Hwy Dept and NRCS only 15 years ago. Elimination of these over-reaching portions of the proposal would alone reduce the cost estimates by $300,000,000.00 or more. M11-2

3) MFCD has not had any opportunity to consult with scientists regarding this proposal, but at least 3 PhDs at the Burlington Public Meeting, and another who has written a letter to the Editor in the Everett HERALD, have all stated the science supposedly supporting the proposal is either flawed or just plain wrong.

Those are the extent of comments MFCD is in a position to make at this time. Further comment would not be based on the ability to actually study the proposal in depth and respond to its membership's comments and questions. Were further comment to be made in this vacuum, it would merely add to the adverse effects on the total failure of the proper notice of the proposal in the first place. It you really hope for property owners to willingly cooperate, more and better contact -- direct contact –must occur.

Thank you for this limited opportunity to comment, but please extend the comment period by at least six (6) months with at least two (2) face to face public meetings with directly affected property owners in Snohomish.

Yours very truly,

Gary W. Brandstetter
MARSHLAND FLOOD CONTROL DISTRICT Secretary/Manager

GWB/g

c: Marshland Flood Control District Commissioners Don Bailey, Marv Thomas and Tim Stocker

7.11.1 Responses to Comment Letter M11

M11-1: See Master Response 2. The public comment period for the Draft Feasibility Report and Environmental Impact Statement was extended by 45 days. The Final Feasibility Report and Environmental Statement will be released for another 30 day review.

M11-2: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer

coordination in the future. The comments included in your letter will be taken into consideration if and when the project is carried forward in the future.

7.12 Comment Letter M12 - Alex Alexander

Getchell Ranch
November 24, 2014

Ms. Nancy Gleason
U.S. Army Corps Of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, WA 98124

Dear Ms. Gleason:

Please find enclosed a commentary/assessment of the proposal *"Puget Sound Nearshore Ecosystems Restoration Project"* (**PSNERP**). The document of 327 pages was received November 10, and a response was prepared to accommodate the November 24 deadline indicated for public comment. I regret that a more thorough commentary was not possible at this time. M12-1

The PSNERP interest in Everett and neighboring properties of North Marshland is particularly relevant. It is an area endowed. For myself and others having a lifetime in Ag research and Snohomish Valley residence, the region holds answers to impending water-crises and research questions that its present owners are not prepared to ask.

Further to this, almost everyone notes the extensive *Time-Line* for PSNERP implication (up to several decades). Taken together, the combined evidence of a prehistoric channel at North Marshland, the continuing elevation of floodwater stages, and the river break-in at Norwegian Bay, prefigure the likelihood of Snohomish River taking a hand in PSNERP affairs, with rechanneling activity at the Everett sub-area. In any case, the proposed alternative plan of restored gravitational drainage for a fish-integrated agriculture remains the realistic land-use option for an Everett sub-area venue rearranged by the river. M12-2

Sincerely,

Alex G. Alexander

3914 52nd St., SE
Everett, WA 98201
(425) 252-7749

[Report is filed in the administrative record at the Seattle District offices]

7.12.1 Responses to Comment Letter M12

M12-1: Comment noted.

M12-2: See Master Response 1. The Everett Marshland project is no longer included in the recommended plan. If and when this project moves forward with Corps involvement, the City of Everett, Marshland Flood Control District, landowners, and other key stakeholders will be notified to ensure closer coordination in the future. The comments included in your letter will be taken into consideration if and when the project is carried forward in the future.

7.13 Comment Letter M13 – Merle Jefferson, Lummi Indian Business Council

LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD BELLINGHAM, WASHINGTON 98226 (360) 312-2000
DEPARTMENT _____ DIRECT NO _____

November 25, 2014

Colonel John Buck, Seattle District Commander
U.S. Army Corps of Engineers
P.O. Box 3755
Seattle, WA 98124

SUBJECT: Lummi Nation Support for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Tentatively Selected Plan

Dear Colonel Buck,

The purpose of this letter is to express the Lummi Nation's continuing support of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) overall and more specifically the Nooksack River Delta element of the Tentatively Selected Plan (TSP).

As you know, the Lummi Nation is a signatory of the Treaty of Point Elliott and is a federally recognized Indian tribe (75 FR 60810). The Treaty of Point Elliot reserved the inherent rights of the Lummi people to hunt, fish, and gather resources throughout its usual and accustomed grounds and stations necessary to maintain the *Schelangen* ("way of life") of our community and culture and to achieve a moderate living standard from fishing for all of its members for all time. The rulings in *U.S. v. Washington* confirmed these treaty-reserved fishing rights and the role of the Lummi Nation as a natural resource co-manager.

M13-1

Without the habitat required to produce a sustainable harvestable surplus of salmon and shellfish, the treaty right to harvest salmon and shellfish is meaningless. As a result, the United States has a trust responsibility to protect and restore the habitat required to support the treaty right fisheries. This responsibility includes the protection and restoration of nearshore habitat critical to salmon and shellfish productivity. We have been working with the Corps (Seattle District), U.S. Fish and Wildlife Service, NOAA Fisheries, and the Washington Department of Fish and Wildlife to identify and evaluate elements of the PSNERP for over a decade. These efforts have included significant in-kind contributions of staff and technical resources. The result of this joint effort with our co-managers is the Nooksack River Delta site of the TSP identified in the Draft Feasibility Report/Environmental Impact Statement for PSNERP.

The Lummi Nation recognizes and supports the commitment of PSNERP to identify and address the longstanding issue of nearshore habitat loss and degradation. The Lummi Nation has extensive involvement and investments, both financially and otherwise, in local restoration

projects, many of which are identified in the TSP. As identified in the Treaty Rights at Risk initiative, Lummi has highlighted the fact that habitat loss continues at a rate that outpaces current recovery efforts and thereby threatens the future of salmon and tribal treaty rights. As a result, the Lummi Nation has been adamant in our request that the federal government protects and restores salmon and shellfish habitat.

It is our understanding that during the Pre-Construction Engineering and Design (PED) phase of the project that a more detailed analysis will be conducted to further evaluate the feasibility of the various elements of the Nooksack River Delta TSP. In particular the potential impacts of increasing flow in the Lummi River channel on navigation and fishing in the lower Nooksack River and the potential impacts of degraded Nooksack River water quality on Lummi Bay shellfish resources will be evaluated. We look forward to continuing to work with your staff and our co-managers to ensure that the ecosystem restoration benefits of the Nooksack River Delta site are maximized in a manner that improves the ability of the Lummi Nation and its members to exercise our Treaty rights. M13-1

Thank you for your attention to this matter. Please do not hesitate to contact me (360-312-2328) if you would like additional information or would like to further discuss this important project.

Sincerely,

Merle Jefferson, Executive Director
Lummi Natural Resources Department

cc: Lynn Wetzler, Project Manager, Seattle District, U.S. Army Corps of Engineers
Nancy C. Gleason, Corps of Engineers
Phil Anderson, Director, WA Dept. of Fish & Wildlife
Theresa Mitchell, Project Manager, WA Dept. of Fish & Wildlife

7.13.1 Response to Comment Letter M13

M13-1: As your letter states, the Corps will complete a more detailed analysis during the PED phase to further evaluate the feasibility of the various elements of the Nooksack River Delta project. The Corps will continue to coordinate closely with the Lummi Nation as these evaluations are completed.

7.14 Comment Letter M14 –Scott Schuyler, Upper Skagit Indian Tribe

Upper Skagit Indian Tribe
25944 Community Plaza Way,
Sedro Woolley, WA 98284
Phone (360) 854-7090 Fax (360) 854-7042

January 6, 2015

Attn: Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, Washington 98124

RE: Upper Skagit Indian Tribe's comments on the draft FR/EIS for the Puget Sound Nearshore Ecosystem Restoration Project

Dear Ms. Gleason,

This letter serves as Upper Skagit Indian Tribe's (hereafter "the Tribe") response to the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) draft FR/EIS released by U.S. Army Corps of Engineers (Corps) and Washington Department of Fish and Wildlife (WDFW). The Tribe appreciates the opportunity to comment on this project, including potential benefits to the Tribe's Treaty protected natural resource rights as well as potential conflicts regarding Tribal cultural artifacts. If constructed, the PSNERP project could foster considerable improvements to fish and shellfish habitat within Puget Sound and could support government obligations to protect the Tribe's Treaty rights. The Tribe applauds the partnership between the Corps and WDFW and supports efforts to protect Treaty rights by restoring habitat function at the 11 sites identified in the FR/EIS. The Tribe requests involvement with future decision processes, particularly for the following six projects that directly impact the Tribe's treaty reserved resources: Deepwater Slough, Dugualla Bay, Milltown Island, North Fork Skagit River Delta, Telegraph Slough and Livingston Bay.

M14-1

The Tribe takes this opportunity to identify two specific comments. First, the Telegraph Slough project in the FR/EIS would restore rearing habitat for Skagit Chinook salmon. Accessibility for these fish to Telegraph Slough could be improved by a separate restoration project at McGlinn Island Causeway. It is reasonable to assume that restoration at Telegraph Slough would increase motivation to complete the McGlinn Island Causeway restoration. However, the completion of the McGlinn Island Causeway project has the potential to impact population distribution in Puget Sound and, by extension, fisheries allocations. The Telegraph Slough

M14-2

project should fully assess potential impacts to fishery allocations and negative impacts to Skagit fisheries. Second, the Tribe is concerned about looming effects of climate change on Skagit fish populations and habitat function in Puget Sound. The PSNERP project would reduce detrimental impacts of climate change on nearshore ecosystems; however, the Tribe feels it may by prudent to consider additional efforts to mitigate climate change. Opportunities to maintain functioning nearshore habitat are expected to become increasingly rare in the face of climate-induced sea level rise. By increasing the scope and footprint to include low gradient adjacent upland areas, the PSNERP project could create room for landward encroachment of tidal influences.

M14-2

M14-3

The Tribe thanks the Corps and WDFW for their efforts thus far and looks forward to being involved in future efforts to develop the PSNERP project. The scale and breadth of the project represent a rare opportunity to make significant improvements to the currently degraded state of the Tribe's treaty resources. Regarding technical issues specific to the six projects identified above, please contact the Tribe's Habitat Biologist, Rick Hartson, at (360) 854-7049, rickh@upperskagit.com, or the Tribe's Natural Resources Managing Biologist, Jon-Paul Shannahan, at (360) 854-7089, jonpauls@upperskagit.com. Regarding Tribal cultural issues, please contact me, Scott Schuyler, Cultural Specialist, at (360) 854-7009, sschuyler@upperskagit.com.

Sincerely,



Scott Schuyler
Head Natural Resources Department and Tribal Cultural Specialist
Upper Skagit Indian Tribe

7.14.1 Response to Comment Letter M14

M14-1: See Master Response 1 and Master Response 2.

M14-2: See Master Response 1 and Master Response 2.The Telegraph Slough and McGlinn Island Causeway projects are no longer included in the recommended plan. If and when these projects move forward with Corps involvement, the affected Tribes, landowners, and other key stakeholders will be notified to ensure close coordination and impacts analysis.

M14-3: Projections of habitat areas in the nearshore zone depend on a variety of factors including land development and zoning, regulatory permitting and enforcement, mitigation requirements, sea-level change, and climate change. During the next design phase, the potential effects of habitat changes would be thoroughly analyzed and benefits will be maximized in the greatest available project footprint.

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX I

ECONOMICS

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps of Engineers
Seattle District

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1 OVERVIEW

This appendix describes the cost effectiveness and incremental cost analysis (CE/ICA) performed for the Puget Sound Nearshore Ecosystem Restoration Project Integrated Feasibility Report and Environmental Impact Statement (Nearshore Study). This process helps in the formulation of efficient and effective restoration solutions throughout Puget Sound, Washington. Because there is no currently accepted method for quantifying environmental benefits (or environmental outputs) in monetary terms, it is not possible to conduct a traditional benefit-cost analysis for the evaluation of project alternatives. Cost effectiveness and incremental cost analyses offer approaches that are consistent with the Principles and Guidelines (U.S. Water Resources Council, 1983; referred to as the "P&G") planning paradigm. Cost effectiveness will ensure that the least cost solution is identified for each possible level of environmental output. Subsequent incremental cost analysis will reveal changes in cost for increasing levels of environmental outputs. While these analyses will usually not lead, and are not intended to lead, to a single best solution (as in economic benefit-cost analysis), they will improve the quality of decision making by ensuring that a rational, supportable, focused and traceable approach is used for considering and selecting alternatives for environmental restoration.

This report briefly summarizes some of the plan formulation and modeling of environmental outputs that focused the scope and inputs of the cost effectiveness and incremental cost analyses. The contents of this appendix are as follows:

- Section 2, Plan Formulation and Identification of Restoration Projects
- Section 3, Formulation of Alternative Plans
- Section 4, Initial Array of Alternatives
- Section 5, Focused Array of Alternatives
- Section 6, Final Array of Alternatives
- Section 7, Tentatively Selected Plan and Recommended Plan
- Section 8, References

2 PLAN FORMULATION AND IDENTIFICATION OF RESTORATION PROJECTS

The planning process which includes the identification of problems, opportunities, objectives and constraints, as well as the identification of management measures, siting of management measures, and screening is documented in Chapter 2 and Chapter 4 of the feasibility report.

To effectively evaluate the 36 sites presented for initial evaluation in Chapter 4 of the feasibility report, the Nearshore Study Team completed additional analysis including development of parametric cost estimates and evaluation of environmental outputs. Based on these parameters, a Cost Effectiveness/Incremental Cost Analysis (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.

2.1.1 Evaluation of Site Benefits

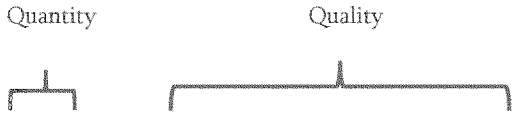
An interdisciplinary team including Corps staff, members of the Nearshore Science Team (NST), and contractor support staff developed an ecosystem output (EO) model to quantify the benefits that each site would provide. The framework of this model is consistent with the Nearshore Study's approach of restoring the ecosystem process, structure, and function that provide habitat and other ecosystem services. The model output is a product of quantity and quality. The quantity component of the model equation is defined as the area of restored process (in acres), and the quality component is comprised of multiple components that capture process, structure, and function. These three quality components are derived from calculations based on spatially explicit data in the Nearshore Geodatabase[1]:

- The process component is represented by one index: process degradation.
- The structure component is represented by five landscape indices: scarcity of landforms, heterogeneity of landforms, long-shore connectivity, cross-shore connectivity, and sinuosity.

[1] The Nearshore Geodatabase was initially compiled as part of the Change Analysis (Simenstad et al. 2011)

- The function component is represented by one index: a site's ability to provide ecosystem functions, goods, and services (EFG&S).

The model equation combines these components as follows:



$$EO = A * [(P^2 + S + F)/\text{maximum possible score}]$$

Where:

EO – ecosystem output (project benefits)

A – area of restored process, in acres (Quantity score)

P – process degradation index score, scale 0 – 10 (process component of Quality score)

S – 2 (Sc + H + Lc + Cc + Sn), scale 0 – 10 (structure component of Quality score)

Sc- scarcity, scale 0-1

H- heterogeneity, scale 0-1

Lc- long-shore connectivity, scale 0-1

Cc- cross-shore connectivity, scale 0-1

Sn- sinuosity, scale 0-1

F – EFG&S Tier 2 score, scale 0 – 10 (function component of Quality score)

Maximum possible score for quality: 120

A documentation report titled "Puget Sound Nearshore Ecosystem Output Model Documentation Report" describes the theory, framework, and detailed methodology of this model and the associated indices listed above (see Appendix G). Corps headquarters (HQ) has reviewed and approved this model for one-time use.

2.1.2 Evaluation of Site Costs

Costs were estimated for the 36 sites and input into IWR Plan for generation of alternatives and for CE/ICA. Costs used in the formulation and evaluation of alternatives are the economic costs of each site design, including pre-construction, engineering, and design (PED) costs; construction and construction management costs; and real estate costs.

Costs for PED and for construction and construction management were developed by Corps cost engineers in Micro-Computer Aided Cost Estimating System (MCACES)[2] using the quantities provided with the conceptual designs, standard features and rates, and input from the PDT. When necessary, quantities were developed by the cost engineer if not provided in the conceptual design reports. Items such as the fuel rates, rock pricing, haul distances, and markups were discussed within the team and held consistent throughout all site designs. Certain features, such as some bridges and levees, were assumed to have similar designs but were sized according to the needs of each alternative site design. Costs developed for the cost effectiveness and incremental cost analysis (CE/ICA analysis) utilized costs at the October 2011 price level and were annualized using a 4% discount rate (FY12 rate) and assumed similar construction durations across sites. Monitoring and adaptive management costs were included as a cost contingency and were confirmed to not to vary considerably among sites, with the study team concluding that these costs would not impact the outcomes of the CE/ICA analysis. Monitoring costs ranged from 0.9-0.95% and adaptive management costs ranged from 2.58-2.85% for each of the sites.

Operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs were not included in this phase of evaluation because little was known about the cost of OMRR&R at the conceptual design level. Expected changes to OMRR&R was evaluated at a conceptual level, but it was subsequently determined that inclusion of OMRR&R costs had a moderate level of uncertainty but would not affect the screening of alternatives at this phase. OMRR&R is evaluated and presented in the project costs for the recommended plan in Chapter 6 of the feasibility report.

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 6.7 of the feasibility report and the Cost Engineering Annex of Appendix B.

2.1.3 Summary of Site Benefits and Costs

An additional round of qualitative evaluation and screening was completed based on site benefits, preliminary costs, technical feasibility, and overall readiness to proceed. After this step, 24 sites were carried forward for additional analysis, evaluation, and screening.

[2] MCASES is cost estimating software used by Corps cost engineers.

Table 2-1 provides an overview of the benefits and costs for the 31 site designs located at 24 sites. The site designs are grouped by strategy, which is shown in the left-most column.

Table 2-1. Benefits and Costs for 31 Site Designs, by Strategy (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs[1]	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output (Net EO)
Delta	Big Quilcene Partial	$35,073	$1,632	25.5	0.6
	Deepwater Slough Partial	$6,652	$310	269.6	90.2
	Duckabush Full	$71,085	$3,309	39.4	12.9
	Duckabush Partial	$58,403	$2,719	38.1	12.3
	Everett Marshland Full	$357,549	$16,644	829.1	349.3
	Everett Marshland Partial	$154,286	$7,182	427.4	167.8
	Milltown Island Partial	$4,246	$198	214.2	64
	Nooksack River Delta Partial	$331,473	$14,132	1,807	650.5
	North Fork Skagit Delta Full	$64,393	$2,998	256.1	53.7
	Spencer Island Partial	$16,916	$787	313.2	136
	Telegraph Slough Full	$188,613	$8,779	832.2	253.9
	Telegraph Slough Partial	$93,922	$4,372	146.9	16.3
Beach	Beaconsfield Feeder Bluff Full	$7,929	$369	6.9	2.2
	Beaconsfield Feeder Bluff Partial	$3,027	$141	5.5	1.3
	Twin Rivers Partial	$5,546	$258	4.3	0.2
	WDNR Budd Inlet Beach Full	$9,569	$446	2	1.1
Barrier Embayment	Big Beef Creek Estuary Full	$32,629	$1,519	29.6	7.9
	Dugualla Bay Partial	$72,289	$3,365	572	162.6
	Livingston Bay Full	$12,863	$599	244.6	41.6
	Livingston Bay Partial	$12,062	$561	238.7	40.5
	Point Whitney Lagoon Full	$9,522	$443	6.1	2
Coastal Inlet	Chambers Bay Full	$288,020	$13,408	83.5	8.5
	Chambers Bay Partial	$96,699	$4,502	47	3.4
	Deer Harbor Estuary Full	$6,679	$311	16.1	4.8
	Harper Estuary Full	$12,240	$569	6.2	1.7
	Harper Estuary Partial	$16,025	$746	5.7	1.1
	Lilliwaup Partial	$30,619	$1,425	19.6	1.1
	Sequalitchew Full	$166,320	$7,743	4.5	0.9
	Snow/Salmon Creek Estuary Partial	$37,798	$1,760	52.2	6.8
	Tahuya River Estuary Full	$28,917	$1,346	36.1	7.6
	Washington Harbor Partial	$17,666	$822	14	0.6

Note: 1. First costs include real estate, design, construction, and construction management.

3 FORMULATION OF ALTERNATIVE PLANS

Level 5 of the plan formulation strategy included cost effective and incremental cost analysis for the 36 sites carried forward from the previous step. As discussed in Section 4.1.2 of the feasibility report, four restoration strategies were developed to address the planning objectives, with one strategy to address Objective 1 (deltas), two to address Objective 2 (embayments - one strategy for barrier embayments and one for coastal inlets), and one to address Objective 3 (beaches). Alternative plans were initially formulated to address each strategy because of the broad variety of and differences between ecological benefits that accrue from restoration of the different landforms. Restoration of the different landforms can have not only cumulative benefits, but potentially synergistic benefits as well. For example, restoring a large river delta site would benefit rearing salmonids, while restoring a beach would restore spawning habitat for forage fish, a primary prey resource for salmonids and many other species. The complexity of interactions among biota dependent on the nearshore zone means restoration benefits are needed across each strategy.

Because outputs from sites of one strategy are not directly comparable to outputs from sites of the other three strategies, and to ensure that the final set of alternative plans includes sites from each strategy, alternative plans were generated through a multi-step process:

- First, the sites were organized into four subgroups, one for each.
- Second, IWR Planning Suite (certified version 2.0.6.0) was used to generate an initial array of alternative plans comprised of all possible combinations of sites within each strategy. Based on this evaluation, one or more cost effective sites within each strategy were carried forward.
- Third, IWR Planning Suite was used to generate a focused array of alternative plans comprised of all possible combinations of the sites across all strategies carried forward from the previous step. Based on this evaluation, a focused array of 23 best buy plans (including the No Action plan) was identified.
- Finally, a final array of four alternatives was carried forward. Each alternative is comprised of multiple sites and addresses all four of the study's strategies.

The USACE Institute for Water Resources (IWR) developed IWR Planning Suite (certified version 2.0.6.0) 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

(for this study we may refer to the outputs as benefits, average annual habitat units or AAHU's, or average annual net ecosystem outputs or net EO), costs, and rules (combinability and dependency relationships) for combining solutions into plans. Plans are then compared in IWR Planning Suite by conducting cost effectiveness and incremental cost analyses (CE/ICA), identifying the plans which are the best financial investments, and displaying the effects of each on a range of decision variables.

Cost effectiveness and incremental cost analyses are useful tools to assist in decision making and support recommendations of environmental restoration projects. Two analytical processes are conducted to meet these requirements. First, cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. Subsequent incremental cost analysis of the least cost solutions (cost effective plans) is conducted to reveal changes in costs for increasing levels of environmental outputs.

A more detailed explanation of this process and the alternative plans selected as a result is presented in the upcoming sections.

3.1 BY-STRATEGY SUBGROUPS

After estimating costs and benefits, the 31 site designs at 24 sites were grouped by strategy they most prominently addressed. This step ensured that sites addressing each of the four strategies (and by extension all planning objectives) would ultimately be included in the implementation strategy described in Section 4.3 of the feasibility report. The sites were grouped by strategy as shown in Table 2-1 and summarized below.

River Delta Strategy (9 sites; 12 site designs):

- Big Quilcene Partial
- Deepwater Slough Partial
- Duckabush Full
- Duckabush Partial
- Everett Marshland Full
- Everett Marshland Partial
- Milltown Island Partial
- Nooksack River Delta Partial
- North Fork Skagit Delta Full
- Spencer Island Partial
- Telegraph Slough Full
- Telegraph Slough Partial

Beach Strategy (3 sites; 4 site designs):

- Beaconsfield Feeder Bluff Full
- Beaconsfield Feeder Bluff Partial
- Twin Rivers Partial
- WDNR Budd Inlet Beach Full

Barrier Embayment Strategy (4 sites; 5 site designs):

- Big Beef Creek Estuary Full
- Dugualla Bay Partial
- Livingston Bay Full
- Livingston Bay Partial
- Point Whitney Lagoon Full

Coastal Inlet Strategy (8 sites; 10 site designs):

- Chambers Bay Full
- Chambers Bay Partial
- Deer Harbor Estuary Full
- Harper Estuary Full
- Harper Estuary Partial
- Lilliwaup Partial
- Sequalitchew Full
- Snow/Salmon Creek Estuary Partial
- Tahuya River Estuary Full
- Washington Harbor Partial

4 INITIAL ARRAY OF ALTERNATIVES

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within each of the four strategies described above. This approach was taken due to the software limitations of IWR Planning Suite which limit the possible number of plan combinations. Not all 31 sites could be analyzed together due to this limitation and therefore the team first ran IWR Planning Suite for each of the four strategies (River Delta, Beach, Barrier Embayment, and Coastal Inlet).

Each run of IWR Planning Suite identified an initial array of cost effective and best buy alternatives comprised of one or more sites within each strategy. For these runs of IWR Planning Suite, all sites within each strategy were identified as combinable with the exception of the sites that had multiple scales (full and partial). This approach ensured that the initial array of alternatives only included a single scale (full or partial) at each site. No sites were dependent on any other sites.

Through comparison of incremental costs and benefits of the best buy plans for each strategy, the PDT identified the sites within each strategy that made sense for inclusion in the next step of alternative formulation and evaluation using the process outlined in ER 1105-2-100 for identification of a NER plan. For each of the four IWR Plan software runs (one for each strategy), the Study team evaluated costs per output for each plan to determine whether it was "worth it" in terms of costs and outputs to carry forward the next cost effective increment. Based on this analysis, one or more plans were identified to be carried forward to the next step of the alternatives formulation process, while some plans were not carried forward due to exceptionally high incremental costs per unit.

The outcomes of these analyses are presented in Sections 4.1 through 4.4.

4.1 RIVER DELTA

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within the river delta strategy using total average annual costs and average annual net ecosystem outputs displayed in Table 4-1. All sites were combinable with exception of the sites which have multiple scales (full and partial). No sites were dependent on any other sites. All possible combinations of sites are displayed in Figure 4-1.

Table 4-1. River Delta Strategy – Benefit and Cost Model Inputs (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output
Delta	Big Quilcene Partial	$35,073	$1,632	25.5	0.6
	Deepwater Slough Partial	$6,652	$310	269.6	90.2
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	North Fork Skagit Delta Full	$64,393	$2,998	256.1	53.7
	Spencer Island Partial	$16,916	$787	313.2	136
	Telegraph Slough Full	$188,613	$8,779	832.2	253.9
	Telegraph Slough Partial	$93,922	$4,372	146.9	16.3

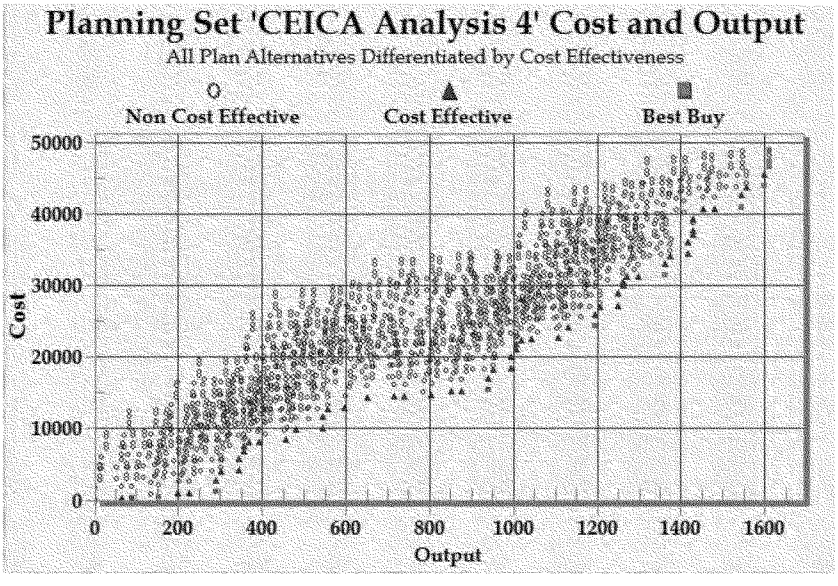

Figure 4-1. River Delta Strategy – Plot of Possible Plan Combinations

The cost effectiveness and incremental cost analysis resulted in 12 best buy plans which effectively and efficiently provide ecosystem restoration outputs, including the No Action plan. These plans are displayed in Table 4-2 and the best buy incremental bar graph in Figure 4-2. The following sections describe the river delta sites that were carried forward for further analysis.

Table 4-2. River Delta Strategy – Incremental Costs of Best Buy Alternative Plans

Alternative Plan	Average Annual Cost ($1,000s)	Average Annual Output (Net EO)	Average Annual Cost/ Output ($1,000s)	Incremental Cost ($1,000s)	Incremental Output (Net EO)	Incremental Cost/Output ($1,000s)
No Action Plan	$0	-	$0	$0	-	$0
Milltown Partial	$198	64	$3.1	$198	64	$3.1
Milltown Partial and Deepwater Partial	$310	90.2	$3.4	$310	90.2	$3.4
Milltown Partial, Deepwater Partial and Spencer Island Partial	$1,295	290.2	$4.5	$787	136	$5.8
Milltown Partial, Deepwater Partial, Spencer Island Partial and Nooksack Partial	$15,427	940.7	$16.4	$14,132	650.5	$21.7
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial and Telegraph Full	$24,206	1194.6	$20.3	$8,779	253.9	$34.6
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, and Everett Marshland Partial	$31,388	1362.4	$23.0	$7,182	167.8	$42.8
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, and Everett Marshland Full	$48,032	1711.7	$28.1	$16,644	349.3	$47.6
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, Everett Marshland Full, and North Fork Skagit Full	$51,030	1765.4	$28.9	$2,998	53.7	$55.8
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, Everett Marshland Full, North Fork Skagit Full, and Duckabush Partial	$53,749	1777.7	$30.2	$2,719	12.3	$221.1
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, Everett Marshland Full, North Fork Skagit Full, and Duckabush Full	$57,058	1790.6	$31.9	$3,309	12.9	$256.5
Milltown Partial, Deepwater Partial, Spencer Island Partial, Nooksack Partial, Telegraph Full, Everett Marshland Full, North Fork Skagit Full, Duckabush Full, and Big Quilcene Partial	$61,430	1806.9	$34.0	$4,372	16.3	$268.2

Note: Pink highlighted plan advanced.

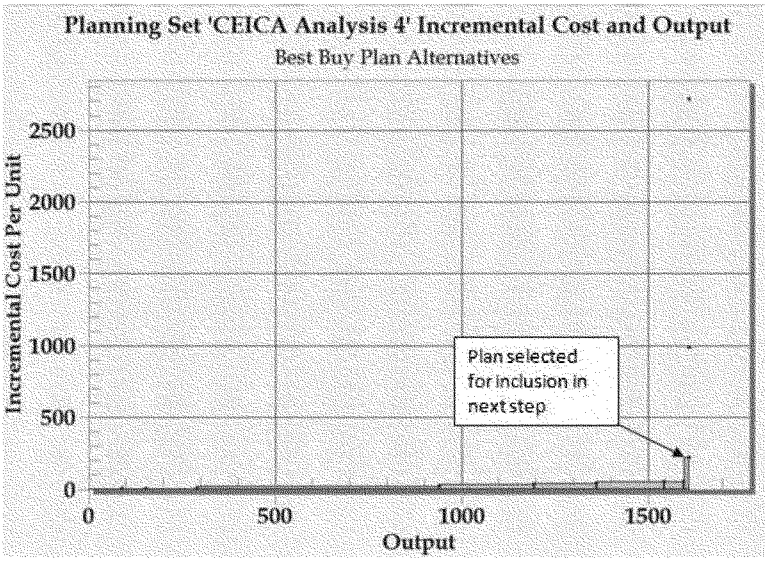

Figure 4-2. River Delta Strategy – Best Buy Plans

4.1.1 Sites included in River Delta Strategy

There are eight best buy sites included in the final array of alternatives that address the river delta strategy. The alternative carried forward for the river delta strategy was selected due to inclusion of the Duckabush River Estuary site, which is located in the Hood Canal sub-basin. Smaller best buy plans do not include sites in the Hood Canal sub-basin, which is a partially isolated geographic section of Puget Sound. Inclusion of the Duckabush River Estuary would provide valuable rearing habitat for Hood Canal summer chum. This best buy plan is more geographically representative of restoration across Puget Sound.

The restoration objective associated with this strategy is to increase the size and quantity of large river delta estuaries by restoring tidal processes and freshwater input where major river floodplains meet marine waters. Target ecosystem processes for river delta restoration include the following:

- Tidal flow
- Freshwater input (including alluvial sediment delivery)

- Erosion and accretion of sediments
- Distributary channel migration
- Tidal channel formation and maintenance
- Detritus recruitment and retention
- Exchange of aquatic organisms

4.1.2 Ecosystem Benefits of Restoration Sites in River Deltas

Qualitative benefits of these eight river delta sites would derive from restoring tidal inundation and hydrology to over 4,000 acres of highly productive estuarine mixing and tidal freshwater marshes. As these tidal marshes evolve, channel networks would form, water quality would improve, vegetation would reestablish and, if a source is present, large woody debris would accumulate. The marshes would be used by steelhead[3], bull trout, and all five species of Pacific salmon, including Chinook. Restoration in the Duckabush River would provide valuable rearing habitat for Hood Canal summer chum. Three of the river deltas represented by these sites, the Nooksack, Skagit, and Snohomish, support some of the largest runs of salmon in the Puget Sound. Increased habitat for salmon, particularly Chinook and chum, would benefit marine mammals, including ESA-listed southern resident killer whales (who feed on these species preferentially for much of the year). Puget Sound is an important stop on the Pacific flyway for migratory birds. Restored tidal marshes would also function as foraging and resting habitat for birds and waterfowl with an abundance of vegetation, invertebrates, and amphibians. Benefits of restoring wetlands in large river deltas will extend to the eelgrass beds located along their fringes by way of improved water quality, sediment delivery, and nutrient supply.

4.2 BEACH

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within the beach strategy using total average annual costs and average annual net ecosystem outputs displayed in Table 4-3. All sites were combinable with

[3] ESA Species

exception of the sites which have multiple scales (full and partial). No sites were dependent on any other sites. All possible combinations of sites are displayed in Figure 4-3.

Table 4-3. Beach Strategy – Benefit and Cost Model Inputs (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs[1]	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output
Beach	Beaconsfield Feeder Bluff Full	$7,929	$369	6.9	2.2
	Beaconsfield Feeder Bluff Partial	$3,027	$141	5.5	1.3
	Twin Rivers Partial	$5,546	$258	4.3	0.2
	WDNR Budd Inlet Beach Full	$9,569	$446	2	1.1

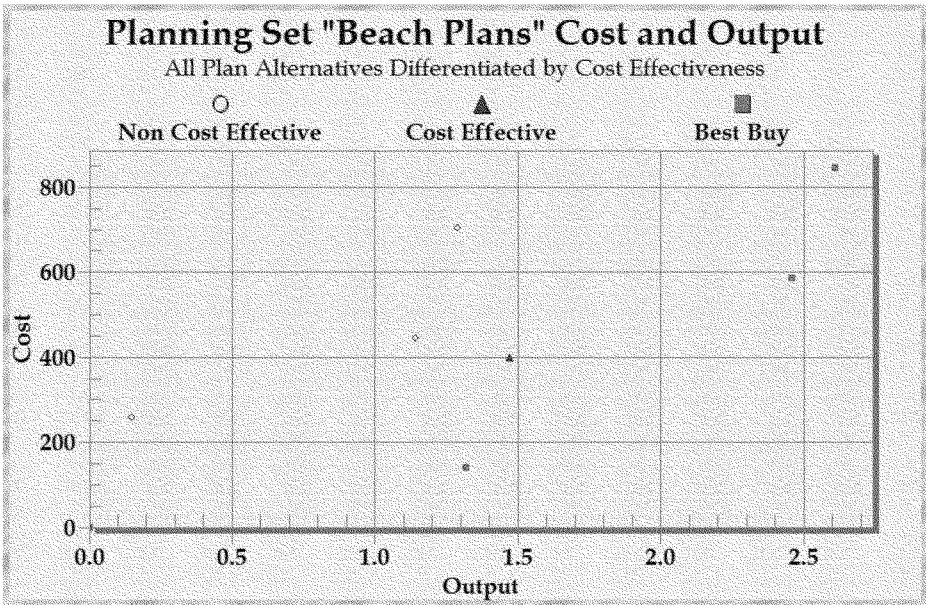

Figure 4-3. Beach Strategy – Plot of Possible Plan Combinations

The cost effectiveness and incremental cost analysis resulted in four best buy plans which effectively and efficiently provide ecosystem restoration outputs, including the No Action plan. These plans are displayed in Table 4-4 and the best buy incremental bar graph in

Figure 4-4. The following sections describe the beach sites that were carried forward for further analysis.

Table 4-4. Beach Strategy – Incremental Costs of Best Buy Alternative Plans

Alternative Plan	Average Annual Cost ($1,000s)	Average Annual Output (Net EO)	Average Annual Cost/ Output ($1,000s)	Incremental Cost ($1,000s)	Incremental Output (Net EO)	Incremental Cost/Output ($1,000s)
No Action	$0	0.0	$0	$0	0.0	$0
Beaconsfield Partial	$141	1.3	$108	141	1.3	$108
Beaconsfield Partial and WDNR Budd Inlet Beach	$587	2.4	$245	446	1.1	$405
Beaconsfield Partial, WDNR Budd Inlet Beach, and Twin Rivers Partial	$845	2.6	$325	258	0.2	$1,290

Note: Pink highlighted plan advanced.

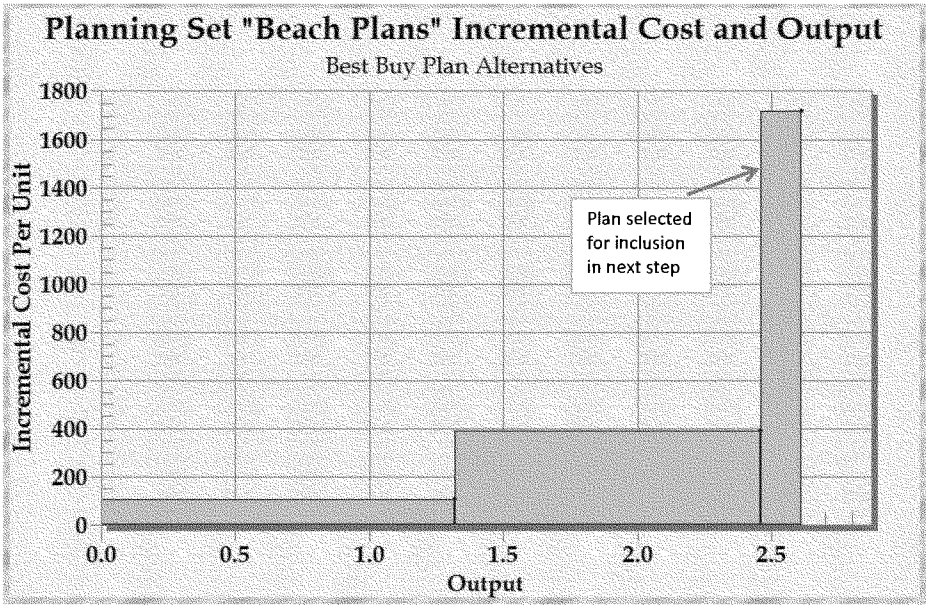

Figure 4-4. Beach Strategy – Best Buy Plans

4.2.1 Sites included in Beach Strategy

There are three best buy sites included in the final array of alternatives that address the beach strategy. Although beach restoration is a critical need for restoration of Puget Sound, the majority of beach real estate is privately held and there is generally a lack of landowner willingness for armor removal and sediment transport restoration. Thus, only three beach sites were identified for initial analysis and all three sites (representing the largest best buy plan) were carried forward. The best buy plan carrying forward three beach sites was selected because these areas represent scarce, high-value nearshore habitat that supports terrestrial and marine components of nearshore ecosystems. Bluff-backed beaches are a key component of the sediment transport process in the nearshore zone and restoration of these sites is extremely valuable. Carrying forward the largest best buy plan for the beach strategy is worth the additional cost of doing so.

Restoration objectives associated with this strategy are to restore the size and quality of beaches by removing or modifying barriers to sediment supply and transport processes to littoral drift cells. Target ecosystem processes for beach restoration include the following:

- Sediment supply
- Sediment transport
- Erosion and accretion of sediments
- Detritus recruitment and retention
- Freshwater input
- Solar incidence

4.2.2 Ecosystem Benefits of Restoration Sites on Beaches

Qualitative benefits of these three beach restoration sites would derive from restoring erosion of the feeder bluffs (currently located behind armoring), as well as sediment transport and deposition. This erosion provides sediment to down-drift areas creating gently sloping beach profiles with shallow water habitat for migration of juvenile salmonids and natural barriers for small coastal embayments. In addition, a variety of substrate sizes provided by the bluff erosion will support colonization of a variety of biota. Populations of epi- and endo-benthic invertebrates like clams, worms and amphipods, as well as forage fish

spawning and rearing would likely increase. Backshore vegetation will establish and large woody debris will accumulative on the beach, functioning as thermal refuge and structure for upper intertidal fauna. Benefits to these lower trophic levels would provide a forage base for marine predators like salmon and nearshore birds. Increased sediment delivery and nutrient input (via detritus) would lead to healthier eelgrass beds along the shoreline. Removal of shoreline armoring and fill from intertidal areas increases upper beach area and connectivity between terrestrial and marine components of nearshore ecosystems.

4.3 BARRIER EMBAYMENT

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within the barrier embayment strategy using total average annual costs and average annual net ecosystem outputs displayed in Table 4-5. All sites were combinable with exception of the sites which have multiple scales (full and partial). No sites were dependent on any other sites. All possible combinations of sites are displayed in Figure 4-5.

Table 4-5. Barrier Embayment Strategy – Benefit and Cost Model Inputs (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs[1]	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output
Barrier Embayment	Big Beef Creek Estuary Full	$32,629	$1,519	29.6	7.9
	Dugualla Bay Partial	$72,289	$3,365	572	162.6
	Livingston Bay Full	$12,863	$599	244.6	41.6
	Livingston Bay Partial	$12,062	$561	238.7	40.5
	Point Whitney Lagoon Full	$9,522	$443	6.1	2

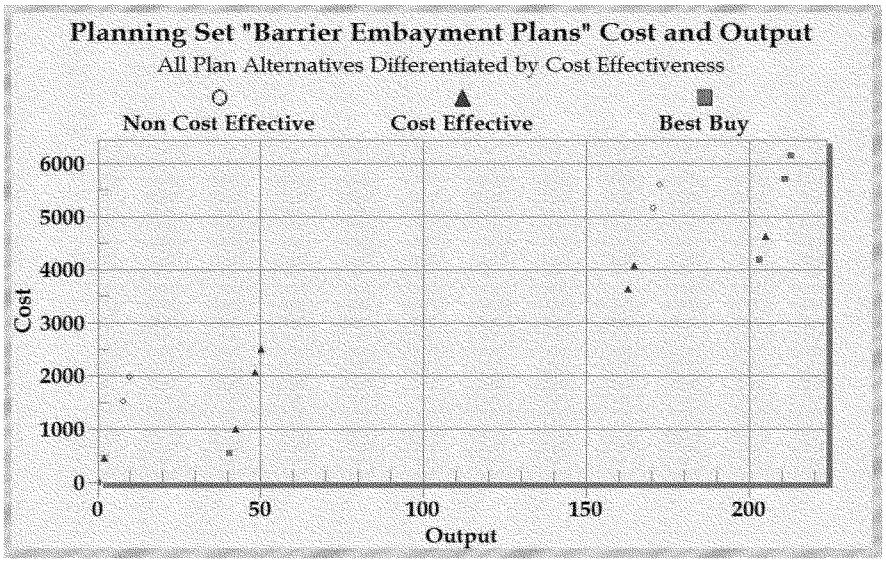

Figure 4-5. Barrier Embayment Strategy – Plot of Possible Plan Combinations

The cost effectiveness and incremental cost analysis resulted in five best buy plans which effectively and efficiently provide ecosystem restoration outputs, including the No Action plan. These plans are displayed in Table 4-6 and the best buy incremental bar graph in Figure 4-6. The following sections describe the barrier embayment sites that were carried forward for further analysis.

Table 4-6. Barrier Embayment Strategy – Incremental Costs of Best Buy Alternative Plans

Alternative Plan	Average Annual Cost ($1,000s)	Average Annual Output (Net EO)	Average Annual Cost/ Output ($1,000s)	Incremental Cost ($1,000s)	Incremental Output (Net EO)	Incremental Cost/Output ($1,000s)
No Action	$0	0.0	$0	$0	0.0	$0
Livingston Bay Partial	$561	40.5	$14	$561	40.5	$14
Livingston Bay Partial, Dugualla Bay Partial	$3,926	203.1	$19	$3,365	162.6	$21
Livingston Bay Partial, Dugualla Bay Partial, and Big Beef Full	$5,445	211	$26	$1,519	7.9	$192
Livingston Bay Partial, Dugualla Bay Partial, Big Beef Full, and Point Whitney Full	$5,888	213	$28	$443	2	$222

Note: Pink highlighted plan advanced.

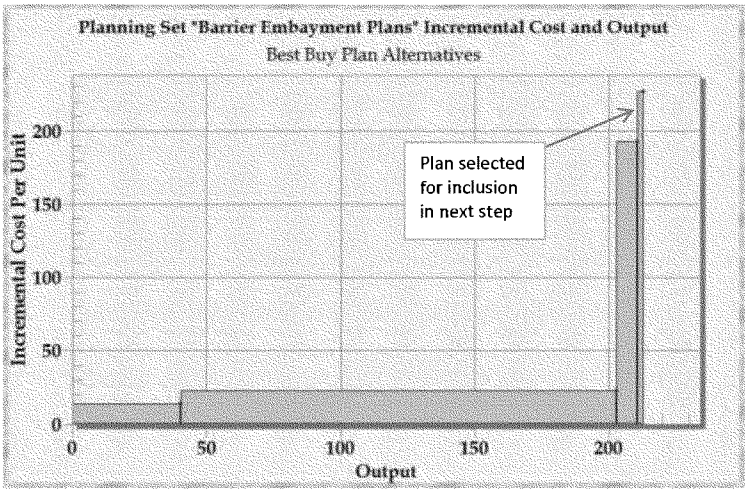

Figure 4-6. Barrier Embayment Strategy – Best Buy Plans

4.3.1 Sites included in Barrier Embayment Strategy

There are four best buy sites included in the final array of alternatives that address the barrier embayment strategy: Big Beef Creek Estuary, Dugualla Bay, Livingston Bay, and Point Whitney Lagoon. The best buy plan carrying forward four barrier embayment sites was selected because these areas represent scarce, high-value nearshore habitat that supports

terrestrial and marine components of nearshore ecosystems. Although there is an increase in incremental cost per output between the best buy plans containing more than two sites, the inclusion of Big Beef Creek Estuary and Point Whitney Lagoon represent an opportunity for restoration in Hood Canal, which is a partially isolated geographic section of Puget Sound. The Point Whitney Lagoon site supports a native oyster population within the lagoon. The Big Beef Creek watershed is largely undeveloped, so restoring the estuary with its eelgrass and shellfish habitats would produce the rare condition of a minimally artificial watershed. Carrying forward the largest best buy plan for the barrier embayment strategy is worth the additional cost of doing so and allows for restoration of a more geographically diverse area.

Barrier embayment restoration objectives are to restore the sediment input and transport processes that sustain the barrier beaches that form these sheltered bays. Objectives also include the restoration of the tidal flow processes within these partially closed systems, often cut off by fill or other constrictions from a tidal connection to Puget Sound. Target ecosystem processes for barrier embayments vary based on extent of freshwater input and nature of the barrier, but in general they include the following:

- Tidal hydrology
- Sediment supply and transport
- Erosion and accretion of sediment
- Tidal channel formation and maintenance
- Detritus recruitment and retention

4.3.2 Ecosystem Benefits of Barrier Embayment Sites

Qualitative benefits of these four barrier embayment sites would derive from restoring or improving tidal influence to 846 acres of marsh, mudflats and tidal channels. Barrier beaches associated with these partially enclosed embayments would also be restored or enhanced. Ecological benefits are similar to those described for open coastal inlets, although there are added benefits of barrier beaches. The presence of this type of beach provides more protection to the embayment as well as structure on the beach itself for invertebrate colonization and forage fish spawning. Restoring barrier embayments also adds to the complexity and length of Puget Sound's shoreline. These ecosystems have high ecological

value, providing essential foraging and rearing habitat for migratory species of birds and juvenile salmonids.

4.4 COASTAL INLET

IWR Planning Suite was used to generate an initial array of alternative plans comprised of all possible combinations of sites within the coastal inlet strategy using total average annual costs and average annual net ecosystem outputs displayed in Table 4-7. All sites were combinable with exception of the sites which have multiple scales (full and partial). No sites were dependent on any other sites. All possible combinations of sites are displayed in Figure 4-7.

Table 4-7. Coastal Inlet Strategy – Cost and Benefit Model Inputs (October 2011 price level)

		Costs ($1,000s)		Benefits	
Strategy	Site Design Name	First Costs	Total Average Annual Costs	Area	Average Annual Net Ecosystem Output
Coastal Inlet	Chambers Bay Full	$288,020	$13,408	83.5	8.5
	Chambers Bay Partial	$96,699	$4,502	47	3.4
	Deer Harbor Estuary Full	$6,679	$311	16.1	4.8
	Harper Estuary Full	$12,240	$569	6.2	1.7
	Harper Estuary Partial	$16,025	$746	5.7	1.1
	Lilliwaup Partial	$30,619	$1,425	19.6	1.1
	Sequalitchew Full	$166,320	$7,743	4.5	0.9
	Snow/Salmon Creek Estuary Partial	$37,798	$1,760	52.2	6.8
	Tahuya River Estuary Full	$28,917	$1,346	36.1	7.6
	Washington Harbor Partial	$17,666	$822	14	0.6

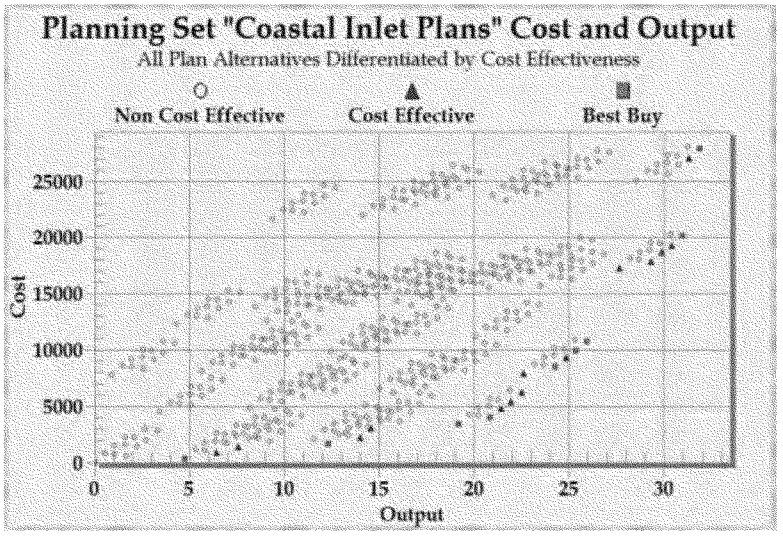

Figure 4-7. Coastal Inlet Strategy – Plot of Possible Plan Combinations

The cost effectiveness and incremental cost analysis resulted in 10 best buy plans which effectively and efficiently provide ecosystem restoration outputs, including the No Action plan. These plans are displayed in Table 4-8 and the best buy incremental bar graph in Figure 4-8. The following sections describe the coastal inlet sites that were carried forward for further analysis.

Table 4-8. Coastal Inlet Strategy – Incremental Costs of Best Buy Alternative Plans

Alternative Plan	Average Annual Cost ($1,000s)	Average Annual Output (Net EO)	Average Annual Cost/ Output ($1,000s)	Incremental Cost ($1,000s)	Incremental Output (Net EO)	Incremental Cost/Output ($1,000s)
No Action	$0	0.0	$0	$0	0.0	$0
Deer Harbor Full	$311	4.8	$65	$311	4.8	$65
Deer Harbor Full and Tahuya Causeway Full	$1,657	12.4	$134	$1,346	7.6	$177
Deer Harbor Full , Tahuya Causeway Full, Snow Salmon Partial,	$3,417	19.2	$178	$1,760	6.8	$259
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, and Harper Full	$3,986	20.9	$191	$569	1.7	$335
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, Harper Full, and Chambers Bay Partial	$5,411	22	$246	$1,425	1.1	$1,295
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, Harper Full, and Chambers Bay Partial, Lilliwaup Partial	$9,913	25.4	$390	$4,502	3.4	$1,324
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, Harper Full, Chambers Bay Partial, Lilliwaup Partial, and Washington Harbor Partial	$10,735	26	$413	$822	0.6	$1,370
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, Harper Full, Lilliwaup Partial, Washington Harbor Partial, and Chambers Bay Full	$24,143	34.5	$700	$13,408	8.5	$1,577
Deer Harbor Full, Tahuya Causeway, Snow Salmon Partial, Harper Full, Lilliwaup Partial, Washington Harbor Partial, Chambers Bay Full, and Sequalitchew Full	$31,886	35.4	$901	$7,743	0.9	$8,603

Note: Pink highlighted plan advanced.

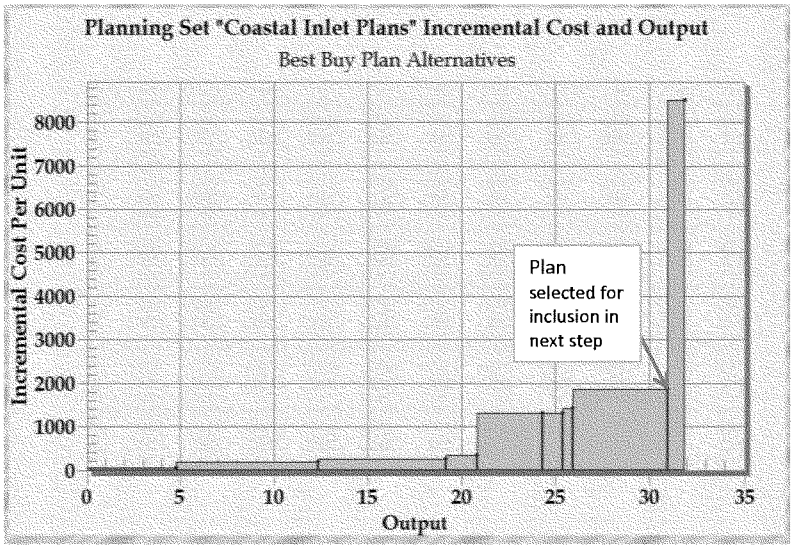

Figure 4-8. Coastal Inlet Strategy – Best Buy Plans

4.4.1 Sites included in Coastal Inlet Strategy

There are seven best buy sites included in the final array of alternatives that address the open coastal inlet strategy. The best buy plan for the coastal inlet strategy was selected because there is a significant increase in incremental cost per output compared to the next larger best buy plan ($1,577,000 to $8,603,000) which would include the Sequalitchew site, with an incremental cost of $7,743,000 for 0.9 AAHU's.

Restoration objectives associated with this strategy are to remove barriers to tidal flow and freshwater input, restoring the quantity and quality of open coastal inlets. Target ecosystem processes for open coastal inlet restoration include the following:

- Tidal flow
- Freshwater input (including alluvial sediment delivery)
- Tidal channel formation and maintenance
- Detritus recruitment and retention

4.4.2 Ecosystem Benefits of Restoration Sites in Coastal Inlets

Qualitative benefits of these four open coastal inlet sites would derive from restoring and/or improving 1) tidal flow to 110 acres of estuarine wetlands and 2) freshwater and sediment input to adjacent nearshore areas. Restoration of these shoreforms adds complexity and length to the Puget Sound shoreline. Estuarine wetlands and associated vegetation, tidal channels and woody debris provide valuable nursery habitat for juvenile salmonids, including ESA-listed Chinook and Hood Canal Summer Chum. Although small in acreage compared with the large river deltas, coastal inlets are essential foraging and rearing "pit stops" for juvenile salmonids during shoreline migration. The improved water quality and exchange of sediment would support the expansion of shellfish populations and highly productive eelgrass beds. Benefits to these lower trophic levels would increase the forage base for birds, mammals, and predatory fish, such as surf scoters, Southern Resident killer whales[4], and bull trout.

[4] Federal ESA-listed species

5 FOCUSED ARRAY OF ALTERNATIVES

IWR Planning Suite was then used to generate a focused array of alternative plans comprised of all possible combinations of the 22 sites carried forward from the previous step. This analysis identified 23 best buy alternative plans that contain one or more sites and address one or more strategies. The 23 best buy plans are shown in Table 5-1 along with the associated average annual cost per output and incremental cost per output for each best buy plan. Each plan builds on the previous plan. Beginning with plan number 2, Deepwater Slough Partial is the only site included in this alternative. Plan number 3 includes Deepwater Slough Partial plus Milltown Island Partial, and plan number 4 includes those two plus Spencer Island Partial. This pattern continues until Chambers Bay Full is added to create the most expensive, highest output plan, plan number 23, which includes 22 sites. The last site added is the site with the highest incremental costs per output. Plans highlighted in green in Table 5-1 were carried forward to the final array of alternatives (described in Section 6).

Table 5-1. Incremental Cost Analysis of Best Buy Plans (October 2011 price level)

Plan No.	Plan Name	Average Annual Output (AAHU or Net EO)	Average Annual Cost ($,1000)	Average Cost / Output ($1,000/AAHU)	Incremental Output (AAHU)	Incremental Cost ($1,000)	Incr. Cost Per Output ($1,000)
1	No Action	0.0	$0	$0	0.0	$0	$0
2	Milltown Island Partial	64	$198	$3.1	64	$198	$3.1
3	plus Deepwater Slough	154.2	$508	$3.3	90.2	$310	$3.4
4	plus Spencer Island Partial	290.2	$1,295	$4.5	136	$787	$5.8
5	plus Livingston Bay	330.7	$1,856	$5.6	40.5	$561	$13.9
6	plus Dugualla Bay	493.3	$5,221	$10.6	162.6	$3,365	$20.7
7	plus Nooksack Delta Partial	1143.8	$19,353	$16.9	650.5	$14,132	$21.7
8	plus Telegraph Slough Full	1397.7	$28,132	$20.1	253.9	$8,779	$34.6
9	plus Everett Marshland Full	1747	$44,776	$25.6	349.3	$16,644	$47.6
10	plus N. Fork Skagit River	1800.7	$47,774	$26.5	53.7	$2,998	$55.8
11	plus Deer Harbor Estuary	1805.5	$48,085	$26.6	4.8	$311	$64.8
12	plus Beaconsfield Bluff	1806.8	$48,226	$26.7	1.3	$141	$108.5
13	plus Tahuya River Estuary	1814.4	$49,572	$27.3	7.6	$1,346	$177.1
14	plus Big Beef Creek Estuary	1822.3	$51,091	$28.0	7.9	$1,519	$192.3
15	plus Duckabush Delta	1834.6	$53,810	$29.3	12.3	$2,719	$221.1
16	plus Point Whitney Lagoon	1836.6	$54,253	$29.5	2	$443	$221.5
17	plus Snow/SalmonCreek	1843.4	$56,013	$30.4	6.8	$1,760	$258.8
18	plus Harper Estuary Full	1845.1	$56,582	$30.7	1.7	$569	$334.7
19	plus WDNR Budd Inlet	1846.2	$57,028	$30.9	1.1	$446	$405.5
20	plusTwin Rivers Partial	1846.4	$57,286	$31.0	0.2	$258	$1,290.0
21	plus Lilliwaup Partial	1847.5	$58,711	$31.8	1.1	$1,425	$1,295.5
22	plus Washington Harbor	1848.1	$59,533	$32.2	0.6	$822	$1,370.0
23	plus Chambers Bay Full	1856.6	$72,941	$39.3	8.5	$13,408	$1,577.4

The following figures show the plot of possible plan combinations for the combined strategies in Figure 5-1 and the incremental cost analysis results graphically in Figure 5-2. As shown in Table 5-1 and Figure 5-2, the incremental average annual cost per output ranges from a low $0/ per output to $1,577 per output. The first 11 plans range in incremental average annual cost per output from $0 per output to $109 per output, while the next 7 plans range in incremental average annual cost per output of $177 per output to $406 per output. A significant increase in cost per output occurs between plans 19 and 20 where the incremental cost per output increases from $406 per output to $1,290 per output. Figure 5-2 shows the incremental cost analysis graphically and indicates the two action alternatives that have been selected for final evaluation and consideration for the TSP, which are listed in Table 5-1 as plan number 12 and plan number 19.

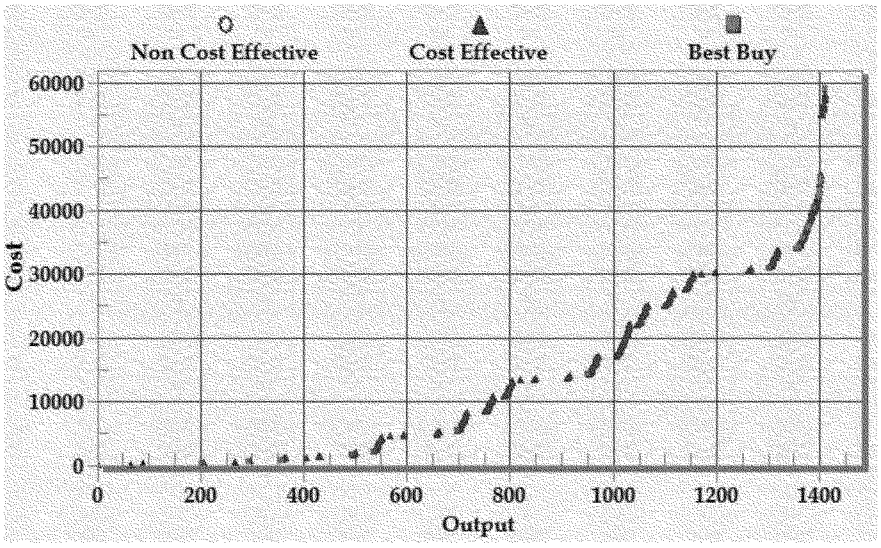

Figure 5-1. Plot of Benefits and Costs for Combined Strategies

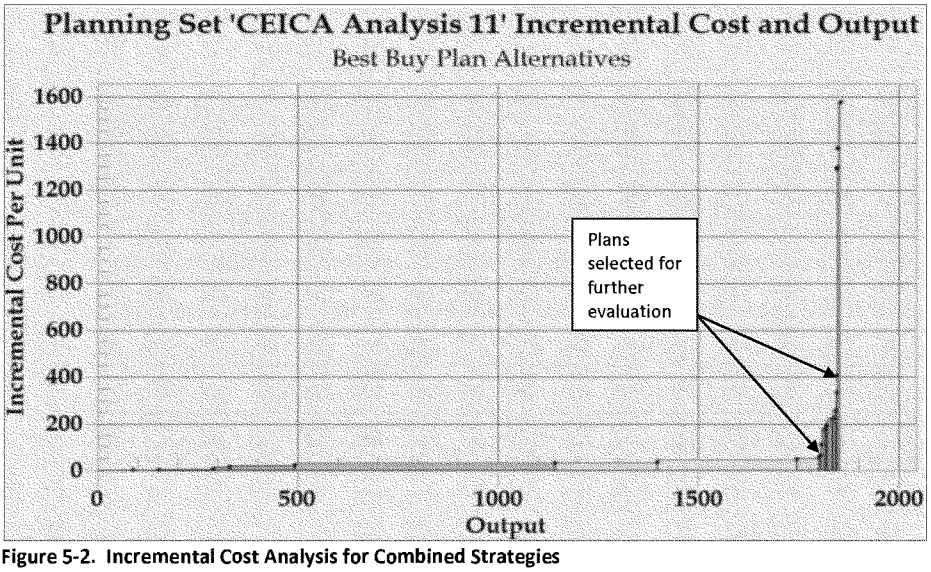

Figure 5-2. Incremental Cost Analysis for Combined Strategies

6 FINAL ARRAY OF ALTERNATIVES

After reviewing the analyses described above, the PDT identified a final array of three best buy alternatives and one non-best buy alternative to be carried forward for final evaluation, comparison, and selection of the TSP. The plans selected for inclusion in the next step of the process are Plan 1, the No Action Plan; Plan 12, which includes 11 sites; and Plan 19, which includes 18 sites. A fourth alternative not included in the CE/ICA analysis was also carried forward based on the results of implementation master plan development described in Section 4.3 of the main report. Following is a summary of the master plan development and criteria applied to arrive at the fourth alternative.

The master plan identifies various approaches for implementation of the 36 projects: General Investigation (GI) projects to be recommended for construction, GI projects recommended for additional study, projects to be completed under existing Corps construction authorities (Continuing Authorities Program (CAP) or Puget Sound and Adjacent Waters Program (PSAW)), and projects to be completed by others. A number of qualitative criteria were identified to categorize sites into the various implementation approaches described above.

Key criteria are summarized below:

- Estimated project costs: Smaller sites (i.e., estimated costs less than $20 million) were generally identified as implementable under CAP or PSAW, while sites with estimated costs greater than $20 million were identified as more appropriate to carry forward under the GI program or be implemented by others. For example, the estimated project cost for WDNR Budd Inlet Beach is approximately $10 million, leading the team to recommend this site for implementation under CAP.

- Restoration potential: Sites were evaluated based on restoration benefits (Ecosystem output, score, type of habitat restored, and location of restoration) and overall restoration potential. For example, restoration of the Nooksack River Delta would provide 25 percent of the Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in a single project. This significant restoration potential led the team to identify this site to be carried forward with a recommendation for construction in a Chief's Report.

- Lands and real estate considerations: Sites were evaluated based on availability of lands as well as amount of lands, easements, rights of way, or relocations required for the project. Evaluation of this criteria included an assessment of whether sites have land already in public ownership or whether sites have large relocation requirements. For example, lands in the project footprint of the Duckabush River Estuary are primarily in public ownership, leading the team to carry this site forward as a GI project to be recommended for construction in a Chief's Report. On the other hand, a lack of landowner willingness at the Beaconsfield Feeder Bluff site led the study team to recommend this project be completed by others.

- Overall readiness to proceed: Considerations of community endorsement, broader regional endorsement, and tribal support assisted the team in determining whether sites were suitable to move forward in the near-term or require additional coordination before site-specific analysis occurs. For example, a number of public comments related to proposed restoration at Everett Marshland led the team to recommend this site for further study under the GI program, allowing for additional coordination with local landowners and community stakeholders.

- Corps policy considerations: Some sites were identified as having outstanding policy concerns that will require additional coordination and analysis before being recommended for construction.

- Finally, 12 sites were identified where restoration work is complete, underway, or will soon be underway by others. These sites were categorized under the "projects to be completed by others" category in the master plan. For example, restoration at Deer Harbor is being carried forward by a local project proponent, leading the team to identify this as a site to be completed by others.

Based on the qualitative evaluation summarized above, the team identified a master plan for strategic implementation of 36 sites across the Puget Sound. Of the 36 sites, three are being recommended for construction authorization under the existing Corps feasibility study and are presented as the recommended plan for this study and is referenced as Alternative 4. There are 9 additional sites that are recommended for additional study, 12 sites that will be completed under the CAP or PSAW; and 12 sites that will be completed without Corps involvement.

Plans 2 through 11 were not carried forward because they do not address all four restoration strategies (river deltas, beaches, barrier embayments, and coastal inlets). Because the Nearshore Study aims to recommend a comprehensive restoration plan that addresses ecosystem degradation across different habitat types and sub basins, these alternatives were not carried forward for further analysis or evaluation.

Plan 12 was carried forward in the final array because it is the first alternative that addresses all four restoration strategies, including beaches. Inclusion of at least one beach site (Beaconsfield) in the final array of alternatives is critical to making progress towards comprehensive restoration across different ecosystem types in Puget Sound. As described in Section 4.5, it is critical to formulate alternative plans that address each of the four restoration strategies because of the broad variety of and differences between ecological benefits that accrue from restoration of the different landforms. Restoration of the different landforms can have not only cumulative benefits, but potentially synergistic benefits as well. Bluff-backed beaches are a key component of the sediment transport process in the nearshore zone, which is why the Beaconsfield site was carried forward.

Plans 13 through 18 were not carried forward in the final array of alternatives; the next plan carried forward for additional analysis was Plan 19. Plan 19 was selected due to the significant increase in incremental cost/output that occurs between Plan 19 and 20 (from $406/output to $1,290/output), as well as the PDT's desire to evaluate a plan that, to the fullest extent possible, takes advantage of identified opportunities to implement cost-effective, high-quality restoration. Compared to Plan 12, Plan 19 contains three additional coastal inlet sites, two additional barrier embayment sites, one additional beach site, and one additional river delta site.

While Plans 20 through 23 have noteworthy environmental benefits, the incremental cost/output increases significantly for each of these plans. Although these plans would more completely address the broad restoration needs in the study area, it was determined that the proposed Federal investment of these plans is not justifiable and viable from a cost perspective.

Finally, one additional alternative was carried forward in the final array. As described in Section 4.3 of the feasibility report, three sites are being recommended for construction authorization in a Chief's Report as part of the Puget Sound Nearshore implementation

masterplan. While this 3-site alternative was not traditionally evaluated using the CE/ICA process summarized in previous sections of this report, it will be carried forward in the final array of alternatives for additional evaluation, comparison, and trade-off analysis.

A summary of the final array of three alternatives is included below. Formal evaluation and comparison of these alternatives is presented in Sections 4.6 and 4.7 of the feasibility report.

No Action Alternative

The No-Action Alternative is synonymous with the "Future Without-Project Condition." The assumption for this Alternative is that no project would be implemented by the Corps to achieve the planning objectives.

Alternative 2 (referenced as Plan 12 above)

Eleven sites were selected for Alternative 2. These sites address all four of the Nearshore Study strategies and are geographically representative of the entire study area (Figure 6-1).

Sites included in Alternative 2 are the following:

- Beaconsfield Feeder Bluff
- Deepwater Slough
- Deer Harbor Estuary
- Dugualla Bay
- Everett Marshland
- Livingston Bay
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta
- Spencer Island
- Telegraph Slough

Alternative 3 (referenced as Plan 19 above)

A total of 18 sites were selected for Alternative 3. Similar to Alternative 2, the sites included in Alternative 3 address all four of the Nearshore Study strategies and are geographically representative of the entire study area (Figure 6-1). Sites included in Alternative 3 are the following:

- Beaconsfield Feeder Bluff
- Big Beef Creek Estuary
- Deepwater Slough
- Deer Harbor Estuary
- Duckabush River Estuary
- Dugualla Bay
- Everett Marshland
- Harper Estuary
- Livingston Bay
- Milltown Island

- Nooksack River Delta
- North Fork Skagit River Delta
- Point Whitney Lagoon
- Snow Creek and Salmon Creek Estuary
- Spencer Island
- Tahuya River Estuary
- Telegraph Slough
- WDNR Budd Inlet Beach

Alternative 4

A total of 3 sites were selected for Alternative **4**. These sites were selected based on the recommendations included in the implementation masterplan described in Section 4.3 of the feasibility report. Sites included in Alternative 4 include the following:

- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

For more detailed information on the site designs, see Appendix B (Engineering Appendix).

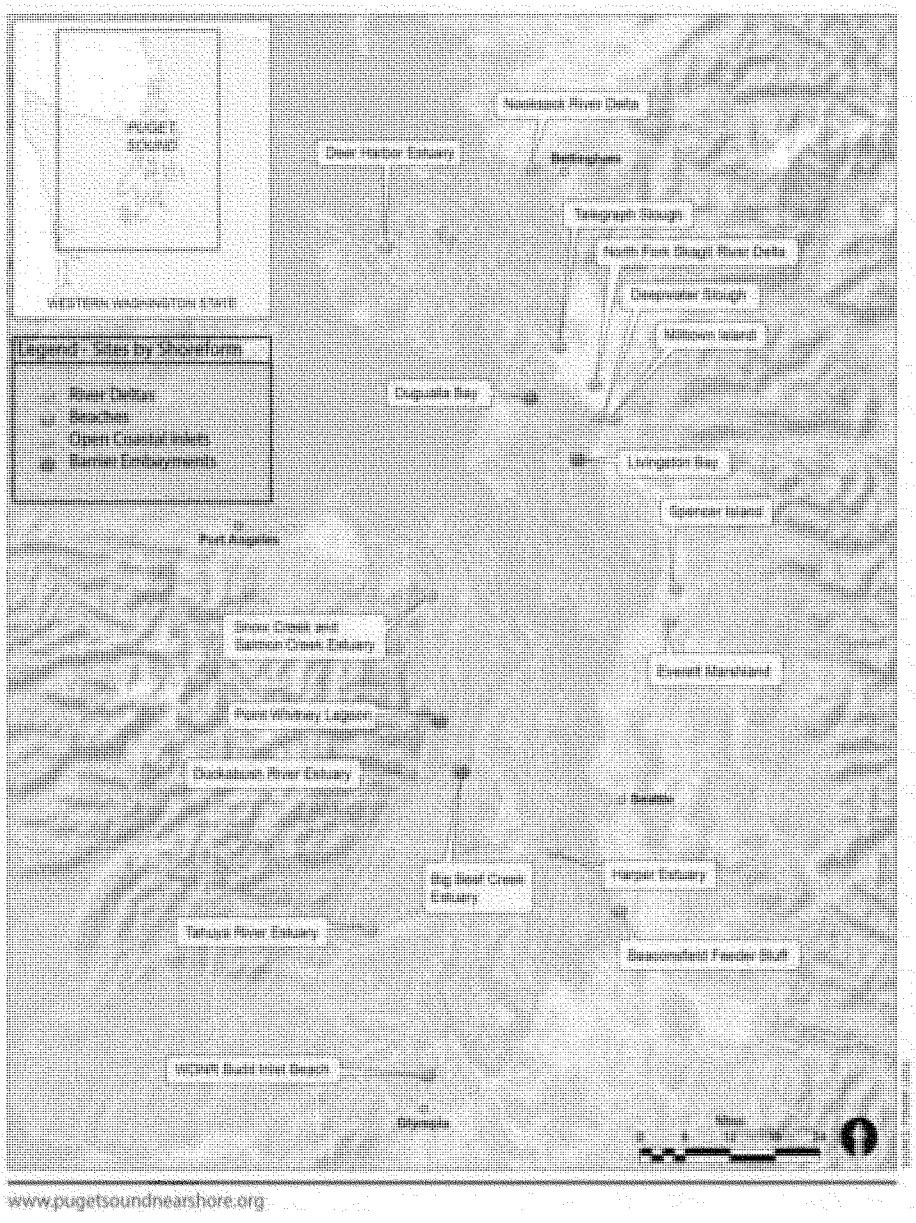

Figure 6-1. Geographic Locations of the Sites included in the Final Array of Alternatives

7 TENTATIVELY SELECTED PLAN AND RECOMMENDED PLAN

The information developed by the CE/ICA and evaluation, comparison, and trade-off analyses presented throughout this chapter 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.

In consideration of the steps taken to formulate scientifically sound, sustainable solutions to solve the stated problems of Puget Sound nearshore ecosystem degradation, and upon review of the results of the evaluation and comparison of alternatives presented throughout this Chapter, Alternative 2 was identified as the Tentatively Selected Plan. Alternative 2 was presented as the TSP in the Draft Feasibility Report/Environmental Impact Statement.

As described in Section 4.3 of the feasibility report, a tiered implementation approach was developed for all 36 sites identified across Puget Sound deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and partners. This strategic masterplan was developed after the TSP was initially identified. As such, the study team revisited the original plan formulation and evaluation results, ultimately revising the TSP to be consistent with the strategic implementation masterplan. Of the 36 sites identified for implementation across Puget Sound, three are being recommended for construction authorization under this existing Corps feasibility study and are presented as the recommended plan. Alternative 4 is the recommended plan and Agency Preferred Alternative and includes the following sites:

- Duckabush River Estuary
- Nooksack River Delta
- North Fork Skagit River Delta

Sites included in the recommended plan range from 28 to 1,800 acres with costs ranging from $90.5 million to $262.1 million per site. The total area of the proposed sites is 2,101 acres, and the estimated cost of all these sites is approximately $452,286,000 at the March 2016 price level. There are no costs or features (local betterments) over the National Ecosystem Restoration (NER) Plan that has been identified for implementation.

Table 7-1 provides an economic summary of the recommended plan. Interest during construction was computed using estimated project costs at the March 2016 price level, anticipated construction durations for each of the 3 sites (they range from 2 to 6 years each), and the current Federal discount rate (3.125% for fiscal year 2016), bringing total investment costs to $528,918,000. Operations and maintenance expenses have been developed for each site. Annual costs were updated using the current cost estimate at the March 2016 price level. Total average annual cost is estimated at $21,910,000, with an average annual cost of $31,000 per AAHU (or net EO). Economic costs and benefits are also presented at the site-specific level in Chapter 6 of the feasibility report, as well as risks and uncertainties by site which are factored into cost contingencies. No significant risks were identified during feasibility phase which could impact computed environmental benefits. Table 7-2 presents site-specific costs and benefits of the recommended plan.

Table 7-1. Economic Summary of the Recommended Plan

	Cost and Benefit Summary of Recommended Plan (Mar 2016 price level)
Interest Rate (Fiscal Year 2016)	3.125%
Interest Rate, Monthly	0.26%
Construction Period, Months	120
Period of Analysis, Years	50
Estimated Cost	$452,286,000
Interest During Construction (IDC)	$76,632,000
Investment Cost	$528,918,000
Average Annual Cost	
Amortized Cost	$21,047,000
OMRR&R	$863,000
Total Annual Cost	$21,910,000
Average Annual Benefits	
Average Annual Habitat Units (AAHUs, or Net EO)	716.5
Average Annual Cost/AAHU	$31,000

Table 7-2. Site-Specific Costs and Benefits of the Recommended Plan (March 2016 price level, 3.125% discount rate)

Site	Total Project Cost	Construction Duration	Annual OMRR&R	Total Annual Cost (including IDC and OMRR&R)	Acres Restored	AAHU
Duckabush	$90,544,000	2 years	$122,000	$3,833,000	38.1	12.3
North Fork Skagit River Delta	$99,601,000	2 years	$36,000	$4,119,000	256.1	53.7
Nooksack River Delta	$262,141,000	6 years	$705,000	$12,147,000	1807	650.5
Total	$452,286,000	10 years	$863,000	$20,099,000	2101.2	716.5

8 REFERENCES

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PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION

APPENDIX J

ENVIRONMENTAL COMPLIANCE DOCUMENTATION

Integrated Feasibility Report and Environmental Impact Statement



US Army Corps of Engineers
Seattle District

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ECOSYSTEMS, TRIBAL AND
PUBLIC AFFAIRS

December 10, 2009

Ms. Chemine Jackels
Environmental Resources Section
U.S. Army Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124-3755

Ref: Puget Sound Nearshore Marine Habitat Restoration Project, Washington
EPA Project Number 09-061-COE

Dear Ms. Jackels:

The U.S. Environmental Protection Agency (EPA) has reviewed the Notice of Intent (NOI) to prepare a Draft Programmatic Environmental Impact Statement (PEIS) for the **Puget Sound Nearshore Marine Habitat Restoration Project**, Washington. We are submitting scoping comments in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act.

Puget Sound recovery is a priority for EPA. We fully support efforts to restore Puget Sound nearshore habitats and ecological processes that have been degraded and interrupted over time by various human influences. Considering our mutual interest in Puget Sound restoration, the Corps of Engineers (Corps) has expressed interest in working jointly with EPA to develop the Programmatic EIS. In response, we think it would be helpful to explore the potential benefit of EPA serving as a cooperating agency for the development of the PEIS. We invite further discussion on this topic in the near future with both the Corps and the Washington Department of Fish and Wildlife (WDFW). For the present, we would like to offer the following brief scoping comments:

Use Valued Ecosystem Components. Valued Ecosystem Components (VECs), such as, specific vegetation communities, forage fish, juvenile salmon, native shellfish, and nearshore birds have been selected to communicate to both managers and the public the value of Puget Sound nearshore restoration. VECs are a means to bridge both ecological and societal values, including economic, cultural, spiritual, and aesthetic values. We support their use to identify key outcome objectives for nearshore restoration, realizing that the specific VECs and environmental outcomes may differ substantially across different subareas of Puget Sound.

Optimize benefits at multiple scales. In developing priorities and assessing benefits we believe the nearshore restoration project should be designed to achieve optimal benefits at the scale of basins, sub-basins, and local deltas or nearshore drift cells.

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Consider climate change. Planning for climate change is critical for a coastal restoration program of this magnitude. We advocate consideration of climate change with respect to both mitigation and adaptation actions over the proposed project period as well as in anticipation of future change and environmental needs beyond the project period.

Benefit from lessons learned. We recommend that project planners and implementers be mindful, articulate, and demonstrative in sharing the lessons learned from other regional coastal restoration initiatives.

Thank you for the opportunity to offer comment. We look forward to working with the lead agencies, whether formally or informally, to maximize the environmental and social benefits of nearshore restoration in Puget Sound. If you would like to discuss these comments or other aspects of the NEPA process, please contact me at (206) 553-2966 or at somers.elaine@epa.gov, or Michael Rylko, our National Estuary Program Lead for Puget Sound, at (206) 553-4014 or at rylko.michael@epa.gov.

Sincerely,

/s/

Elaine L. Somers
Environmental Review and Sediment Management Unit

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ECOSYSTEMS, TRIBAL AND
PUBLIC AFFAIRS

December 30, 2014

Ms. Nancy C. Gleason
U.S. Army Corps of Engineers
CENWS-EN-ER
P.O. Box 3755
Seattle, Washington 98124

Re: U.S. Environmental Protection Agency Comments on the U.S. Army Corps of Engineers Puget Sound Nearshore Ecosystem Restoration Study Draft Integrated Feasibility Report and Environmental Impact Statement. EPA Project Number 09-061-COE.

Dear Ms. Gleason:

We have reviewed the Corps' Puget Sound Nearshore Ecosystem Restoration Study Draft Integrated Feasibility Report and Environmental Impact Statement (draft FR/EIS). This review was conducted in accordance with the EPA's responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act. Section 309 specifically directs the EPA to review and comment in writing on the environmental impacts associated with all major Federal actions. Our review of the draft FR/EIS considers the expected environmental impacts of the proposed action and the adequacy of the EIS in meeting the procedural and public disclosure requirements of NEPA.

Our interest in this draft FR/EIS is also informed by the EPA's recognition of Puget Sound as an estuary of national significance and approval of the Puget Sound Partnership's Action Agenda as the Comprehensive Conservation and Management Plan of the Puget Sound National Estuary Program.

Project summary
The draft FR/EIS documents the planning process for ecosystem restoration of the Puget Sound nearshore zone. The purpose of the proposed action is to restore the natural processes in the nearshore zone that sustain the biological, economic, and aesthetic resources important to the people of the Puget Sound region and the nation in a cost-effective and socially feasible manner with minimal risks, and to facilitate effective monitoring and adaptive management to maximize attainment of restoration objectives. The need for the proposed action comes from recognizing that valuable natural resources in Puget Sound have declined to a point that the ecosystem may no longer be self-sustaining without immediate intervention to curtail significant ecological degradation.[1]

There are two alternatives, Alternative 2 – the preferred alternative and Tentatively Selected Plan, and Alternative 3. Alternative 2 includes 11 sites that, taken together, would remove 75,172 feet of stressors

[1] draft FR/EIS, p. 6

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from the nearshore zone (most of which are tidal barriers, nearshore fill, and shoreline armoring) and restore 5,354 acres of tidally influenced wetlands in river deltas and shallow embayments. Alternative 3 includes 18 sites that would remove 113,094 linear feet of shoreline stressors and restore 5,517 acres of tidally influenced wetlands. Alternative 2's average annual cost over the 50-year period of analysis is $48,268,000; the average annual cost for Alternative 3 is $57,071,000.

Problems and opportunities

Based on a series of white papers available at *www.pugetsoundnearshore.org*, and according to the draft FR/EIS, there have been major direct and widespread changes to Puget Sound nearshore ecosystems. We agree that these observations support a science-based problem statement and provide a focus for evaluating alternatives and formulating a restoration plan. Past physical changes and stressors of particular concern to the EPA include the following: [2]

- 55.5% of the historical wetlands (57,823 acres) in the 16 largest deltas of Puget Sound have been eliminated.
- 93.1% of the tidal freshwater and oligohaline transitional wetlands have been lost.
- Embayments historically accounted for 689 miles of Puget Sound shoreline (23.2%) but now account for 375 miles of shoreline (15.0%); this represents a decline in length of 45.5%.
- Changes to beaches and bluffs have resulted in the loss of sediment supply and the interruption of sediment transport processes. Armoring occurs along 33.4% of bluff-backed beaches and 27.2% of barrier beaches.
- The current shoreline is about 15% shorter than the historical length of the shoreline. Artificial shoreline now represents about 9.5% of the shoreline of Puget Sound.

These physical changes, which continue today, have contributed to significant degradation of Puget Sound's natural resources. For example, the diking, draining and filling of freshwater and estuarine wetlands have contributed to a situation where most Puget Sound Chinook Salmon populations are at a small fraction of their historic levels. Several populations within the Nooksack, Lake Washington, mid-Hood Canal, Puyallup, and Dungeness basins have returns of fewer than 200 adult fish, signifying extinction risk.[3]

While these problems are significant, we agree with the draft FR/EIS that opportunities exist to restore Puget Sound nearshore ecosystem processes and, thereby, contribute to the health of species that depend on that habitat, directly or indirectly, for survival. We applaud the Corps and Washington Department of Fish and Wildlife for your efforts on this project and note that restoring nearshore ecosystems is consistent with the Puget Sound Action Agenda, the EPA's mission to protect human health and the environment, and the purpose of the NEPA.

> The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.[4]

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[2] draft FR/EIS, chapter 2
[3] draft FR/EIS, p. 69
[4] Sec. 2 [42 USC § 4321]

Responsiveness to EPA's scoping comments
The draft FR/EIS is responsive to EPA's December 2009 scoping comments. In our 2009 scoping comments, we recommended that the Nearshore Study team: optimize benefits at multiple scales while developing priorities, consider climate change in project planning, use Valued Ecosystem Components to identify objectives, and benefit from lessons learned from other regional coastal restoration initiatives. The draft FR/EIS addresses each of these recommendations. Moving forward, we believe there are additional opportunities to make changes to the final FR/EIS that would more fully protect the environment and assess environmental impacts. Our recommendations are detailed below.

Valued Ecosystem Components
We believe that the draft FR/EIS has positively identified relevant Valued Ecosystem Components (VEC). We agree that coastal forests, beaches and bluffs, eelgrass and kelp, forage fish, great blue heron, juvenile salmon, killer whales, native shellfish, and nearshore birds are VECs that are likely to be enhanced by nearshore restoration, have direct or indirect value to humans socially, culturally, or environmentally, and are recognized as emblematic of a healthy Puget Sound.

To more fully assess environmental impacts in the final FR/EIS, consider including additional information relating project benefits to ecological outcomes for identified VECs. For example, the draft FR/EIS clearly states that Hood Canal summer chum populations have been declining since 1978.[5] The draft FR/EIS also describes how three proposed restoration sites (in Alternative 3) would benefit Hood Canal summer chum salmon by providing rearing habitat for juveniles and restoring shoreline processes that sustain beaches and kelp and eelgrass beds for forage fish spawning (a preferred prey item).[6] What is less clear is the extent or likelihood that project benefits would reverse or contribute to reversing the recent and ongoing declining trend for Hood Canal summer chum populations.

To address our interest in additional information relating project benefits to ecological outcomes for identified VECs, we recommend that the final FR/EIS include a discussion of the influence of project actions on trend predictions. We understand that relating project benefits to trend predictions for all VECs may not be possible. Where possible, however, we believe influence on trend predictions could help decision makers better understand the scale of this project's potential long-term benefits relative to ongoing problems. For example, are project benefits in Hood Canal likely to reduce or reverse Hood Canal summer chum population decline? Or, for example, how would project actions influence Bolte and Vache's[7] predictions for tidal wetland loss by 2060?

Optimize benefits at multiple scales
We believe it is important to address all four Nearshore Study restoration strategies (river delta, barrier embayment, coastal inlet and beach) and appreciate that both alternatives meet this criterion. While we agree that both alternatives include at least one restoration site to address each of the four strategies, we do not agree that both alternatives are geographically representative of the entire study area. At the basin scale, we are concerned that the preferred alternative, Alternative 2, only includes restoration sites in

[5] draft FR/EIS, p. 69
[6] draft FR/EIS, p. 152
[7] See draft FR/EIS, p. 36

four of the Study's seven delineated sub-basins for Puget Sound. Alternative 3 is more geographically representative at the basin scale because it has restoration sites in all seven sub-basins – including: the Strait of Juan de Fuca, Hood Canal and South Puget Sound. We believe it would be more geographically comprehensive to select Alternative 3 as the preferred alternative.

Benefits which are unique to Alternative 3 and which we would highlight include:

- taking the opportunity to produce the rare condition of a Puget Sound watershed with minimal development impacts in Hood Canal's Big Beef Estuary – home to three species of salmon;
- improving an especially diverse area by restoring the Duckabush Estuary, home to herons, eelgrass, herring spawning areas, shellfish beds, seal haulouts and pupping areas, trumpeter swan feeding areas, waterfowl concentrations and winter range for Roosevelt Elk, as well as six salmonid populations;
- providing at Harper Estuary at least one site on the west side of Puget Sound for habitat connectivity between altered shorelines;
- addressing spawning habitat for forage fish species in the Strait of Juan de Fuca at Snow Creek and Salmon Creek Estuary, and in the southernmost inlet of Puget Sound at Budd Inlet Beach.

To address our interest in optimizing benefits for the entire study area, we recommend that the Corps identify Alternative 3 as the preferred alternative.

Benefit from lessons learned

In our 2009 scoping comments we recommended that the project planners and implementers be mindful, articulate, and demonstrative in sharing the lessons learned from other regional coastal restoration initiatives. Draft FR/EIS section 1.7, Prior Studies, Reports, and Existing Water Projects is partially responsive to our recommendation. Section 1.7 is responsive because it lists the Corps Seattle District's experience with studies and restoration projects in the Puget Sound area. Based on this experience - and the Corps' expertise in water-related resource problems - we agree that the Corps is well suited to take the lead on this large-scale restoration effort.

While Section 1.7's list is helpful, and we agree that the Corps is well suited to this task, we recommend that the final FR/EIS include additional information on actual lessons learned from other coastal restoration projects – both within the Seattle District and elsewhere in the country. What are key characteristics of restoration proposals within the Seattle District and elsewhere in the country that have been successfully funded and implemented? What large scale restoration project in the U.S. is analogous to this Study, how has the Seattle District learned from this experience? What are some examples of nearshore restoration techniques, such as dike breaching, which have been especially successful? How have lessons learned from other projects across the country been integrated into planning for this Study?

Linking protection and restoration

We agree with the draft FR/EIS that protection of healthy functioning portions of the nearshore zone is often a more cost-effective approach to ensuring delivery of ecosystem functions, goods, and services.[8] We also understand that protection is not a Corps mission and that protection-focused actions will need to be addressed outside of the Corps authority by local, State or tribal organizations. Because protection is a key component of improving Puget Sound, we believe the final FR/EIS should include additional information on the link between protection and restoration. Describe, in the final FR/EIS, how ongoing

[8] draft FR/EIS, p. 39

and predicted protection efforts are likely to support and work in sync with this project's restoration efforts. The final FR/EIS should – to the extent possible - improve decision-makers' confidence that restoration investments in Puget Sound will result in a net improvement – as opposed to a mitigating effect on ongoing adverse trends resulting from inadequate protections.

Climate change
We appreciate the draft FR/EIS's information on sea-level change (SLC) and vertical land movement (VLM). We also appreciate that the Study team will continue to evaluate sea-level change models, and further resolve VLM rates for site-specific project planning during the preconstruction engineering and design phase. What is less clear is whether SLC, VLM, or other climate impacts influenced the selection of restoration sites. Some restoration sites may be more inherently climate resilient than others - such as having relatively more flexibility to shift landward. In order to address our interest in inherent climate resiliency, we recommend that the final FR/EIS discuss how climate resiliency factored into the formulation of the final array of alternatives. If the analysis suggests that changes to the suite of restoration sites based on climate information would result in greater overall benefits, consider making changes to the final array of alternatives.

EPA rating
We are rating the draft FR/EIS Environmental Concerns – Insufficient Information (EC-2). A copy of our rating system is enclosed. Our "EC" rating relates to our concern regarding the limited geographic approach of Alternative 2 and our preference for a more geographically comprehensive alternative. Our "2" rating relates to our recommendations to provide additional information on VECs, lessons learned, protection opportunities and climate change.

Thank you for this opportunity to comment and if you have any questions, please contact me at (206) 553-1601 or by electronic mail at reichgott.christine@epa.gov, or Erik Peterson, the lead reviewer for this project. Erik can be reached at (206) 553-6382 or peterson.erik@epa.gov.

Sincerely,

Christine Reichgott, Unit Manager
Environmental Review and Sediment Management Unit

Enclosure:

1. EPA Rating System for Draft Environmental Impact Statements

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements Definitions and Follow-Up Action*

Environmental Impact of the Action

LO – Lack of Objections

The U.S. Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC – Environmental Concerns

EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO – Environmental Objections

EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU – Environmentally Unsatisfactory

EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 – Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 – Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 – Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public

comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Drive SE, Suite 102
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RECEIVED
SEP 05 2006

Bernard L. Hargrave, Federal Project Manager
Puget Sound Nearshore Ecosystem Restoration Project
U.S. Army Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Mr. Hargrave:

Attached is the summary of U.S. Fish and Wildlife Service (USFWS) participation in the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) for federal fiscal year (FY) 2005. This Planning Aid Letter is being submitted to fulfill commitments under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et.seq.) for FY 2005. This Planning Aid Letter was prepared for the USFWS's Western Washington Fish and Wildlife Office by Curtis Tanner who provided the majority of USFWS support for PSNERP in FY 2005.

In general, USFWS remains satisfied with the direction of PSNERP. Federal funding for the GI Study has been lower than originally anticipated during the initial scoping the General Investigation Study. Despite this, good progress has been made towards study completion, and the release of interim work products has provided information that is useful in on-going coastal habitat restoration activities in Puget Sound and has helped define the direction and progress of the Study.

The key USFWS conclusions of this report are:

- We support the investment that PSNERP has made towards advancing early action projects.
- We are eager to see the results of Stage 2 and delivery of the Strategic Needs Assessment Report.
- We anticipate that emerging PSNERP work product will help inform our own restoration programs and endangered species recovery efforts.

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We look forward to continued involvement in PSNERP, and to the opportunity to help contribute to this effort and benefit from its results. Please contact Curtis Tanner at (360) 902-2815 or Tom McDowell (360 753-9426) if you have any questions related to this Planning Aid Letter or our Fish and Wildlife Coordination Act activities for this project.

Sincerely,

for Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

Enclosures

Planning Aid Letter Attachment One:

Summary of FY 2005 Fish and Wildlife Coordination Act Activities for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)

Project Background

PSNERP General Investigation Study

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a large-scale, comprehensive initiative that affords a unique opportunity to tackle some of the foremost habitat restoration needs in Washington State's Puget Sound basin. Project goals are to identify significant ecosystem problems, evaluate potential solutions, and restore and preserve critical nearshore habitat. PSNERP is a partnership between the U.S. Army Corps of Engineers (Corps) and local sponsors. The Washington Department of Fish and Wildlife represents the local project sponsors. Other major project partners contributing to this effort with direct and in-kind support include other state and federal government agencies, Indian tribes, industries and environmental organizations.

In 2001, PSNERP initiated a Corps General Investigations Study (GI) designed to proceed through three stages, culminating with a final report to Congress in Fall 2009 (Figure 1). In the first stage of the project, PSNERP partners have worked to develop tools and information necessary to complete the study, including a nearshore conceptual model, guidance for implementing restoration projects, and historic (c.a. 1850) shoreline maps. PSNERP is currently working to apply concepts and tools developed during Stage I to improve understanding of where and how important nearshore ecosystem processes have been altered by human activity in the Puget Sound basin. The outcome of Stage II will be a strategic needs assessment to identify "what is broken" in Puget Sound nearshore ecosystems. This characterization will examine evidence of changes in ecosystem processes at various scales; this assessment is essential to the formulation of a restoration plan in Stage III. It is anticipated that the GI will results in justification for implementation of specific large scale restoration projects, and possibly an Ecosystem Restoration Program authority for implementation by the Corps and others.

By assessing the most pressing restoration needs for different parts of Puget Sound, PSNERP hopes to provide guidance for other public and private entities such as Native American tribal governments, local governments, regional fisheries enhancement groups, salmon recovery lead entities, marine resource committees, non-profit conservation and advocacy groups, and local "friends" groups. The Corps and other PSNERP partners can then focus their efforts on those identified projects and other needs that are beyond the capacity of local partners and existing restoration programs.

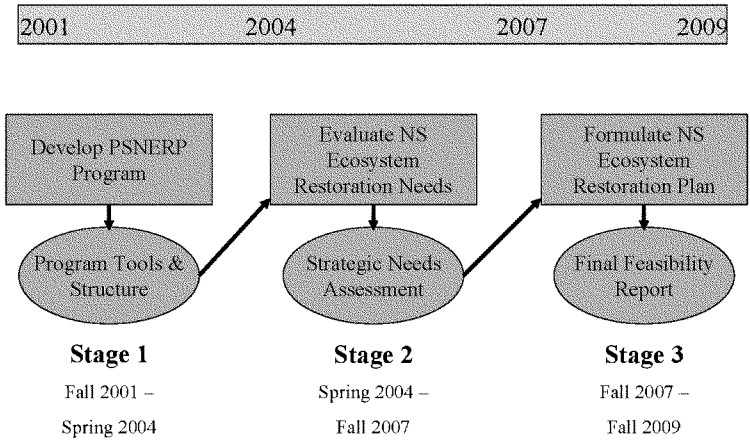

Figure 1: PSNERP Major Program Stages and Milestones

PSNERP and the Nearshore Partnership

Since initiation of the GI, PSNERP has attracted considerable attention and support from a diverse group of individuals and organizations interested and involved in improving the health of Puget Sound nearshore ecosystems and the biological, cultural, and economic resources they support. To recognize this broadening interest and mission, the name "Puget Sound Nearshore Partnership" was adopted by the program in 2004, and a program logo was commissioned (Figure 2). The intent of the PSNERP Steering Committee in doing so was to describe a growing and diverse group, and the work being undertaken which ultimately supports the goals of PSNERP, but is beyond the scope of the GI Study. Collaborating with the Puget Sound Action Team, the Nearshore Partnership seeks to implement portions of the PSAT Work Plan pertaining to nearshore habitat restoration issues. While the mission of PSNERP remains at the core of the Nearshore Partnership, restoration projects, information transfer, scientific studies and other activities can and should occur to advance understanding, and ultimately, the health of the Puget Sound nearshore beyond the original focus and scope of the on-going GI Study.

Current participants in the Puget Sound Nearshore Partnership include:

Interagency Committee for Outdoor Recreation
King Conservation District
King County
National Wildlife Federation
NOAA/National Marine Fisheries Service
NOAA Fisheries – Restoration Center

Northwest Indian Fisheries Commission
Pacific Northwest National Laboratory
People for Puget Sound
Pierce County
Puget Sound Action Team
Salmon Recovery Funding Board
Taylor Shellfish Company
The Nature Conservancy
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Geological Survey
U.S. Fish and Wildlife Service
U.S. Navy
University of Washington
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington Department of Natural Resources
Washington Public Ports Association
Washington Sea Grant
WRIA 9



Figure 2: Puget Sound Nearshore Partnership Logo

USFWS Participation

The U.S. Fish and Wildlife Service (USFWS) Western Washington Fish and Wildlife Office has been an active participant in PSNERP from the start of Phase I. Our involvement largely falls under two USFWS activities, the Coastal Program and Federal Activities. Our role through the Coastal Program has been provision of technical expertise, largely through participation in PSNERP Nearshore Science Team. Our role under Federal Activities is primarily the completion of responsibilities associated with the Fish and Wildlife Coordination Act.

Historical Involvement

Nearshore Science Team

USFWS involvement in PSNERP was initiated in FY 2002 when the Coastal Program accepted an invitation from the Steering Committee to fill a position on the Nearshore Science Team (NST). The specific request was for Curtis Tanner to provide expertise in the field of habitat restoration to the interdisciplinary team. According to PSNERP Policies and Procedures, full-member participation in the NST is estimated to require 0.25 FTE, or one-quarter (25%) of a full-time work position. USFWS has consistently

renewed this commitment, and we continue to provide technical expertise on issues of coastal habitat restoration on the NST. To date, this contribution has been cost-shared equally between the Coastal Program and the U.S. Army Corps of Engineers.

Implementation Team

In FY 2003 the PSNERP Steering Committee initiated activities of the Implementation Team. Initial members were Curtis Tanner and Jacques White, then representing People for Puget Sound on the PSNERP Steering Committee. The initial tasks of the Implementation Team focused on outreach to other programs and organizations in the Puget Sound region involved in habitat restoration and protection. Presentation materials were developed and delivered to a wide range of audiences, including all Puget Sound lead entities, marine resource committees, and numerous other groups including Puget Sound Action Team local liaisons, WDFW watershed stewards, and regional fishery enhancement groups. Other early IT activities focused on development of a list of "management measures" or restoration and conservation actions that are appropriate for implementation by PSNERP. In December 2004, IT activities greatly diminished when Dr. White left People for Puget Sound to establish a Marine Program for The Nature Conservancy of Washington, and Mr. Tanner assumed local project manager responsibilities for PSNERP. In 2005, the IT was reconstituted with new leadership and members, and a focus on identification and implementation of "early action projects".

Steering Committee

During the period of FY 2002-04, USFWS was represented on the PSNERP Steering Committee by Lynn Childers, Manager of the Division of Federal Activities for WWFWO. In FY 05, Mr. Childers accepted a detail assignment to the Washington Department of Transportation to improve coordination between the two agencies. At the same time, Curtis Tanner assumed local project manager responsibilities for PSNERP, including co-chair of the Steering Committee. It was determined that this involvement was sufficient to insure effective USFWS participation in PSNERP program guidance, and Mr. Childer's position was not replaced. Currently, USFWS does not have direct representation on the PSNERP Steering Committee, and this issue is periodically revisited by USFWS management.

Executive Committee

USFWS has been consistently represented on the PSNERP Executive Committee by the WWFWO Manager, Ken Berg. Mr. Berg brings his perspective on the wide range of USFWS functions and activities under his direction, as well as his participation in other regional initiatives and partnerships to the Executive Committee. He has also worked to focus attention of USFWS upper management on the importance of PSNERP activities, and has offered it as an example of regional collaboration that should be the focus of agency activities.

Other USFWS Support

FY 2005 Early Action Project Funds

In addition to in-kind support provided by agency staff participation in various PSNERP work groups, teams, and committees, USFWS has provided other support to the program. In FY 2005, $25,000 of Coastal Program discretionary funds were granted to the Washington Department of Fish and Wildlife to support implementation of early action projects. These funds were provided to supplement other "on-the-ground" project implementation funds, with the intent of improving understanding of restoration actions anticipated on larger scales by PSNERP. To date, a small portion of these funds have been used to assist development of a comprehensive monitoring plan for the Skokomish dike removal project in southern Hood Canal. Remaining funds are currently planned to be used to assist project construction activities, including possible improvements to plans for restoration of hydrologic connections between the project area, Hood Canal, and the Skokomish River.

Current Involvement

USFWS staff are currently extensively involved in PSNERP, participating in all levels of the program, including management and technical work groups. In addition to the participation described above, USFWS Coastal Program member Curtis Tanner is currently devoting 0.70 FTE to Local Project Management under an agreement between USFWS and the Washington Department of Fish and Wildlife. Curtis has been in this position since December 2004. The scope of his duties as described by this agreement include:

1. Providing leadership for PSNERP Steering Committee
2. Participation as member of Project Management Team
3. Fulfillment of responsibilities of Local Project Manager
4. Represent PSNERP in external forums, conferences, etc.

FY 2005 PSNERP Activities

Fiscal year 2005 (October 2004 – September 2005) was a productive year for PSNERP. Important advances were made in completing Work Plan activities for the GI Study, and Nearshore Partnership activities, related to but not directly a part of the GI Study, served to expand program benefits to a wider audience.

Significant accomplishments

Ft. Worden Retreat

In May 2005, the PSNERP Project Management Team organized an "all-hands" program retreat at Ft. Worden. The primary topic discussed by 20 members in attendance from the Steering Committee, Implementation Team, and Nearshore Science Team were alternatives to address the "gap" between work plans and project accomplishments. This widening discrepancy between the original work plan for the GI and project completion is due to a lower than anticipated level of program funding. By the end of FY 2005, total

project funding was $4.5 M, as compared to $10.5 M estimated by the work plan. Similarly, 40% of necessary tasks have been completed, as compared to 85% estimated by the end of this fourth year. Project Managers felt it important to check-in with team members, and work towards a report to the Executive Committee as requested for their July 2005 meeting. Four "general" options for addressing this gap were discussed in detail at Ft. Worden:

Alternative 1. Original Scope with a New Timeline (Take longer)
Alternative 2. Change to more Limited Scope (Do less)
Alternative 3. Phased Approach (Deliver Project in Increments)
Alternative 4. Continue the General Investigation study while implementation of Early Action Projects proceeds.

Meeting participants reached consensus around the idea that the project was properly scoped, and that scaling back to "do less" was inconsistent with the original intent of an ecosystem approach to Puget Sound restoration. The following summarizes the plan for action that emerged from the Ft. Worden retreat:

Phased Approach with Milestones

- Work with the existing Strategic Work Plan, and its projection of Stage 2 completion by April 2008.
  - The Project Management Team committed to reviewing the Work Plan to determine if this schedule can be reasonably compressed, especially with increased resources, to complete Stage 2 in FY 2007.
- Complete Stage 2 tasks leading to the delivery of a *Strategic Needs Assessment Report*, containing:
  - Our understanding of "where and how Puget Sound is broken" (i.e. restoration needs)
  - A statement of how much needs to be fixed to achieve desired levels of improvement in the health of Puget Sound (i.e. restoration goals)
  - A description of the tools available to the Nearshore Partnership to address these restoration needs and goals (i.e. management measure list)
  - A working list of the potential project opportunities that might address identified needs (i.e. restoration opportunities list)
  - A list of specific early action projects for construction by the Corps
- Steering Committee and Project Management Team would establish priorities given limitations of time and resources – establish schedule and stick to it.
- Establish completion of Stage 2 as a major Program milestone with key decisions to be made following completion Strategic Needs Assessment Report of the of how to proceed with the remainder of the GI:
  - Is there sufficient level of uncertainty (unknown problems/unknown solutions) to continue "study" part of GI?
  - Is there sufficient list of justified "Corps projects" to advance an interim feasibility report of:
    - demonstration (learning experiences,)
    - urgent and obvious (medium size projects, high certainty of benefits)

- Is there a sufficient gap in capability of existing restoration programs/authorities (e.g. SRFB, PSAW, §206/1135) to warrant advancing major projects (large, complex) into a Puget Sound Nearshore Restoration Program Construction General Authority (new Corps authority)?

These recommendations were reported to the Executive Committee in July 2005, and approved. The Ft. Worden retreat provided PSNERP team members a useful "check-in", helped to confirm the direction and schedule of the project, and served to refocus efforts on completion of Stage 2 and delivery of the Strategic Needs Assessment Report.

Technical Reports

In 2005, PSNERP began widespread distribution of its technical reports. While completed primarily to advance the GI, Steering Committee members believed that the work of those not directly involved in PSNERP would benefit from this information. Enhancements necessary to facilitate "web publishing" were completed on the program website, and the first three reports posted:

1. Application of "Best Available Science" in Ecosystem Restoration: Lessons Learned from Large-Scale Restoration Efforts
2. Guidance for Protection Guidance for Protection and Restoration of the Nearshore Ecosystems of Puget Sound
3. Guiding Restoration Principles

These Technical Reports have been well-received by a wide audience. The information is being used to help inform restoration project activities, and has served to reinforce the credibility and relevance of the program.

Typology/Historic Conditions Characterization

Using funds provided by WRIA 9/King Conservation District, an important pilot study of the project's technical approach was completed. Historic shoreline data (c.a. 1850-70) were used in combination with the NST Typology (shoreline geomorphic classification) to characterize historic nearshore conditions. An effective collaborative approach was adopted by the Nearshore Science Team and the contractor selected for this project, CommEn Space. The outcome of this effort was an important successful "proof of concept" applying the analytical methods developed by the NST to real-world data. The Project Management Team is now working to implement next steps identified by the pilot study.

Potential Nearshore Projects List

Implementation Team co-lead Elaine Kleckner worked with Interagency Committee for Outdoor Recreation (IAC) staff to develop a database for managing a list of potential nearshore projects. IAC's PRISM database structure was adopted for future migration of the Nearshore Project database into a PRISM "nearshore module." Elaine contacted lead entities, marine resource committees, and tribes for their lists of potential nearshore projects, generating over 500 entries in the database.

This accomplishment serves a variety of important functions. First, it helps build the data management infrastructure that will be necessary in Stage 3 for identifying and evaluating potential projects for formulation of a ecosystem restoration plan and completion of the Final Feasiblity Report. Second, it identifies potential "early action projects" which could be advanced by the Nearshore Partnership or others. Implementing and monitoring early action projects will help inform future project development activities, while contributing to improvements to the overall health of the Puget Sound nearshore ecosystem.

Observations and Recommendations

The Puget Sound Nearshore Ecosystem Restoration Project continues to make significant progress towards completion of the General Investigation Study and delivery of a Final Feasibility Report. As evidenced by the results of the Ft. Worden retreat, program managers and team members have a long-term vision for the project, choosing an ambitious work plan with the potential for substantial benefits associated with a new ecosystem restoration authority for Puget Sound. Funding has clearly limited progress, and delayed delivery of anticipated program benefits. However in a period of tightening federal resources, PSNERP has continued to garner the support of both Congress and the Administration, as evidenced by modest annual increases in federal funding. Some of this success is likely due to the Seattle District's choice to highlight PSNERP as a District priority, and to the personal support and involvement of the District Engineer.

Federal project managers have done an excellent job of maintaining progress towards completion of the GI study despite lower than anticipated levels of funding. Simultaneously, Corps leadership, including the Project Manager and the District Engineer, have been responsive to the interests of the local sponsor and their partners. They have recognized the importance of using PSNERP information, technical reports, project lists, and other resources to support on-going restoration activities. This willingness to demonstrate flexibility in promoting ancillary Nearshore Partnership activities is insuring that the lessons of PSNERP are being translated to improved on-the-ground project results, and a more strategic approach to identification of restoration priorities.

It is also evident that the Corps is also beginning to employ PSNERP "lessons" in other programs, including the Puget Sound and Adjacent Waters Program. Connections are also being established between the program and Corps regulatory functions. Corps District staff continue to seek creative solutions to include monitoring and adaptive management as project elements, despite resistance from headquarters and national-level guidance documents.

Conclusions

In general, USFWS remains satisfied with the direction of PSNERP, as evidenced by our continued support for the program. We understand that project managers have made good progress in the face of limited resources. While we are eager to see additional results from the program, and successful completion of the Feasibility Report, we concur with

the decision to maintain the original scope of the program, despite the delay in delivery schedule.

We also support the investment in program resources that has gone towards advancing early action projects, and other activities not directly associated with the GI work plan. Project managers are striking a good balance in this area, helping to advance on-going restoration efforts without significant detriment to completion of the GI. It is anticipated that the advances in nearshore restoration, improvement in nearshore condition, and understanding and acceptance of a process-based approach to restoration far outweigh any diminution in project progress.

We are eager to see the results of Stage 2, and delivery of the Strategic Needs Assessment Report. The WWFWO anticipates that this PSNERP work product will help inform our own restoration programs and endangered species recovery efforts. If the product emerges as described in the project Work Plan, we are committed to its use in aligning the restoration work of our programs and our partners to be consistent with the PSNERP strategic restoration approach.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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DEC 17 2008

Bernard L. Hargrave, Project Manager
Puget Sound Nearshore Ecosystem Restoration Project
U.S. Army Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Mr. Hargrave:

Enclosed is a Planning Aid letter summarizing the U.S. Fish and Wildlife Service's (USFWS) participation in the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) for federal fiscal year 2007. This Planning Aid Letter is being submitted to fulfill commitments under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) for FY 2007. The Planning Aid Letter was prepared for the USFWS Western Washington Fish and Wildlife Office by Curtis Tanner who provided the majority of USFWS support for PSNERP in FY 2007

In summary, USFWS supports PSNERP and is satisfied with its progress and direction. Recent increases in federal and state funding for PSNERP have allowed for a substantial increase in program activity and progress towards completion of the PSNERP General Investigation study. Early program pilot study methods have been refined and are now being scaled up to application at a Puget Sound wide scale. These analytical methods will inform the large scale restoration and protection actions of federal agencies and will also help guide actions at more local scales.

Key USFWS conclusions of this Planning Aid letter include:

- Implementation of the Estuary and Salmon Restoration Program by PSNERP as an early action program benefits fish and wildlife resources and improves understanding of nearshore ecosystems.
- The emphasis on science to inform the PSNERP GI study is consistent with USFWS guidance. Implementation of product and programmatic peer review will insure the integrity of PSNERP developed and applied science.
- We strongly encourage PSNERP to continue its cooperation with the Puget Sound Partnership

TAKE PRIDE IN AMERICA

We look forward to continued USFWS involvement in, and support for the activities of PSNERP. Please contact Curtis Tanner at (360) 902-2815 or Tom McDowell at (360) 753-9426 if you have any questions related to this Planning Aid letter or our Fish and Wildlife Coordination Act activities for this project.

Sincerely,

for Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

Planning Aid Letter Attachment One:

Summary of FY 2007 Fish and Wildlife Coordination Act Activities for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)

Project Background

PSNERP General Investigation Study

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a large-scale, comprehensive initiative that affords a unique opportunity to tackle some of the foremost habitat restoration needs in Washington State's Puget Sound basin. Project goals are to identify significant ecosystem problems, evaluate potential solutions, and restore and preserve critical nearshore habitat. PSNERP is a partnership between the U.S. Army Corps of Engineers (Corps) and local sponsors. The Washington Department of Fish and Wildlife represents the local project sponsors. Other major project partners contributing to this effort with direct and in-kind support include other state and federal government agencies, Indian tribes, industries and environmental organizations.

It is anticipated that this General Investigation Study (GI) will result in the identification of a portfolio of multiple, large-scale ecosystem restoration actions. These projects would form the basis for a request to Congress for Corps authority to undertake an ecosystem restoration program in Puget Sound. As the Corps and its partners work towards completion of the GI, information being developed as part of the study is being delivered to assist on-going restoration programs and projects. This dual focus of initiating large-scale strategic restoration actions and the support of more local scale projects makes PSNERP of particular interest to the U.S. Fish and Wildlife Service (USFWS).

Puget Sound Nearshore Partnership

In 2004, the PSNERP Steering Committee recognized that the scope of the GI study, while central to the issue of restoring the health of Puget Sound, was too limited to address some current areas of interest for its members. Specifically, the implementation of on-the-ground projects is not typically part of a GI study and beyond the scope of PSNERP. "Coastal Habitats in Puget Sound" (CHiPS), the U.S. Geological Survey (USGS) initiative devoted to applied research in Puget Sound, began in fiscal year 2006. CHiPS was a result of collaboration between the PSNERP Nearshore Science and USGS scientists to develop a research plan in support of PSNERP[1]. This initiative has allowed USGS research scientists to focus on key information

[1] Coastal Habitats in Puget Sound: A Research Plan in Support of the Puget Sound Nearshore Partnership. Available at: http://www.pugetsoundnearshore.org/techical_papers/coastal_habitats.pdf

gaps critical to improved coastal ecosystem management and restoration. As pressure on the program from the Steering Committee and other stakeholders to "learn by doing" and provide more direct support to projects mounted, the program needed to expand. The Steering Committee adopted a new more inclusive name of "Puget Sound Nearshore Partnership" to represent an expanding, diverse group of stakeholders involved in nearshore ecosystem protection and restoration, and those tasks beyond the scope of this GI study.

Estuary and Salmon Restoration Program (ESRP)

Perhaps the most significant outcome of an expanded mission beyond the PSNERP GI study is the implementation of the Estuary and Salmon Restoration Program (ESRP). As part of Governor Gregoire's new focus on Puget Sound, the Washington State legislature created ESRP in state fiscal year 2007 (July 1, 2006 thru June 30, 2007). The legislature charged the Washington Department of Fish and Wildlife with the implementation of ESRP, in coordination with the Nearshore Partnership. In its first year, ESRP allocated $2.5 million in state funding to nine high-priority projects. ESRP funds were matched with an additional $5.3 million in other state, federal, and local resources. According to WDFW's report to the legislature and Governor[2], in its first year the program advanced "actions on the ground" that will result in:

- Restoration of 808 acres of estuary
- Re-established access to 22 miles of stream
- Acquistion of 300 feet of shoreline
- Protection for 3 acres of riparian buffer
- Removal of 56,250 feet of levee and dikes

USFWS Participation

The USFWS Western Washington Fish and Wildlife Office (WWFWO) continues its active involvement in, and support for, PSNERP. Our involvement carries out responsibilities of two WWFWO program areas, the Watershed Protection & Restoration Branch's Puget Sound Coastal Program and the Division of Consultation & Technical Assistance's Branch of Federal Activities. This Planning Aid Letter has been prepared as part of our Federal Activities duties as defined by the Fish and Wildlife Coordination Act (16 U.S.C. 661-667).

Nearshore Science Team

As with previous years dating back to the origins of the program, USFWS has continued participation in PSNERP largely thru the Nearshore Science Team. Curtis Tanner, a USFWS Coastal Program biologist, is a member of the NST, providing expertise in the field of habitat restoration to this interdisciplinary team. He has served in this role since FY 2002. During this time his involvement has been cost-shared by the USFWS and the Corps. Corps support is provided thru an agreement under the Fish and Wildlife Coordination Act, USFWS funding is provided by the Coastal Program. In addition to full participation in monthly meetings of the NST and associated responsibilities, Mr. Tanner also has an active role in two NST workgroups, the Change Analysis workgroup and Future Without Project workgroup.

[2] 2006 Estuary and Salmon Restoration Program Report. Available at: http://www.pugetsoundnearshore.org/program_documents/esrp_nov0106.pdf

Implementation Team

During federal Fiscal Years 2006-07, PSNERP Project Managers reinitiated the activities of the program's Implementation Team (IT). Originally convened to focus on outreach of program activities to restoration community partners, the revised IT's expanded areas of responsibilities now include:

- Leading cross-program development of the PSNERP Stage 2 deliverable: Strategic Needs Assessment Report (SNAR)
- Development of technical memo series defining categories of potential PSNERP restoration activities: Management Measures
- Technical review of proposals submitted for funding under the Estuary and Salmon Restoration Program

A member of the previous IT, Curtis Tanner continued his active involvement as a member of this expanded team.

In FY 2006, Mr. Tanner also served as the Interim Program Manager for ESRP. Working with the IT, he facilitated review of 24 proposals, the selection of 9 projects for funding, and the enhancement of 4 projects with additional resources for monitoring and outreach activities. In 2007, Mr. Tanner worked with NOAA to provide the services of Paul Cereghino to assume ESRP program management. Mr. Tanner and Mr. Cereghino work closely to insure coordination between the PSNERP GI study and implementation of ESRP.

Steering Committee

In addition to his PSNERP activities supported by the Corps and USFWS, Curtis Tanner also serves as PSNERP Local Project Manager, under an agreement between USFWS and WDFW. This agreement is currently supported through June 30, 2009. The Local Project Manager and the Federal Project Manager (Bernie Hargrave, Seattle District Corps of Engineers) serve as co-chairs of the Nearshore Partnership Steering Committee.

Executive Committee

During FY 2006-07, the USFWS continued its representation on the PSNERP Executive Committee by the WWFWO Manager, Ken Berg. Mr. Berg brings his perspective on the wide range of USFWS functions and activities under his direction, as well as his participation in other regional initiatives and partnerships to the Executive Committee. He has highlighted the program during his discussions with other federal agency leaders, suggesting it provides an example for interagency cooperation for the emerging Puget Sound Partnership and other collaborative initiatives.

Other USFWS Involvement

In addition to the formal areas of direct PSNERP involvement identified above, other informal coordination has insured a prominent role for USFWS in the work of the Nearshore Partnership. In FY 2007, this included improved coordination with the USFWS Coastal Program on ESRP and National Coastal Wetland Conservation Grant program. The Skokomish dike removal project, resulting in over 100 acres of restored estuary habitat at the mouth of the Skokomish River, is an example of both program coordination and joint funding between USFWS and ESRP. Coastal Program staff from the USFWS Western Washington Fish and Wildlife Office have also participated in the most recent (state FY 2008) ESRP review process.

FY 2007 PSNERP Activities

PSNERP has made steady progress towards completion of the General Investigation study since the last USFWS Planning Aid Letter, which summarized activities through federal fiscal year 2005 (September 30, 2005). This timeframe has been characterized by increased funding for the GI from both federal (Corps) and non-federal sources. At the end of FY 2007, the federal cumulative total expended on the program since FY 2002 ($4.1 million) surpassed non-federal spending ($4.0 million), for the first time. This was due to a significant increase in Congressional support for PSNERP, which began in FY 2006 ($0.75 million), and was carried through in FY 2007 ($1.4 million). This increase in program funding has led to much improved progress towards completion of the GI study, and the ultimate goal of an ecosystem restoration authority for Puget Sound.

Technical Reports

One measure of program performance is the emergence of the Nearshore Partnership's technical report series.[3] Sixteen technical reports have been peer-reviewed and published, and a variety of other less-formal materials are also available from the program website. These technical report provide ready access to the emerging science of PSNERP, and are being used throughout the Puget Sound region to improve restoration project implementation.

One of the more significant program accomplishments is the completion of the "Valued Ecosystem Component" (VEC) white paper series. These 10 technical reports provide an objective summary of the literature relating nine PSNERP defined VECs to the nearshore ecosystems which provide support. A tenth paper describes human values associated with the VECs. In addition to publication and distribution via the program website, PSNERP has also distributed electronic copies of technical reports on mini-CD's at regional and national conferences, workshops, and meetings.

[3] Technial reports are available at: http://www.pugetsoundnearshore.org/technical_reports.htm

WRIA 9 Pilot Studies

In FY 2007, PSNERP completed pilot studies intended to develop and evaluate analytical methods. Using data available for all of Puget Sound, the Nearshore Science Team, in collaboration with Contractors, has developed a method for organizing historic and current conditions data, and conducting a "change analysis" on several metrics of nearshore ecosystem condition. In August 2007, the program released the final WRIA 9 Change Analysis report, including appendices and delivery of spatial data and data derivatives.

Sound-wide Analysis

Completion of pilot studies and the evaluation of results has allowed the program to advance to Sound-wide analysis. Recent collaboration with other organizations involved in similar analysis at more local scales, including the Northwest Indian Fisheries Commission and the Skagit River Systems Cooperative, has led to further refinements in methods. This collaboration includes use of a common current conditions data set, to be developed jointly by PSNERP and NWIFC.

Contractor Selection

To support Sound-wide change analysis and other tasks necessary to complete the GI study and produce a Final Feasibility Report, the Corps selected a consultant team to be "on-call" for the program. This specific contracting mechanism, referred to as "Indefinite Delivery/Indefinite Quantity" (IDIQ) provides PSNERP ready access to a diverse team of national and regional experts, as well as journeyman-level "production" staff. The selection process was highly competitive. Corps project managers exercised their discretion in allowing non-Corps PSNERP Project Management Team representatives to participate in the selection process. This served to broaden the perspective of the review team, enhancing the process, and sharing responsibility beyond the Corps. A consultant team lead by Anchor Environmental, and supported by over 20 sub-consultants, was selected as the PSNERP IDIQ contractor. The first task order was awarded to Anchor late in FY 2007, and authorizes their acquisition and organization of data required to complete Sound-wide Change Analysis. Preliminary results of the Anchor team, including a "data dictionary" have been favorable, demonstrating a capacity by the Contractor to successfully complete the complex analysis required by PSNERP.

Coordination With Other Initiatives

While making steady progress towards completion of the General Investigation study, and applying emerging science to on-the-ground projects, another important area of focus for PSNERP and the Nearshore Partnership has been coordination with other initiatives. This deliberate focus on collaboration has helped improve program support, and kept the work of the GI "relevant" to the larger restoration community.

Puget Sound Partnership

Perhaps the most significant development in efforts to protect and restore Puget Sound has been the emergence of the Puget Sound Partnership. Established by Governor Gregoire as an intitative in 2005, the Puget Sound Partnership (PSP) was ratified by the Washington State legislature as a new state agency beginning July 1, 2007[4]. The Puget Sound Partnership combines the previous work of the Puget Sound Action Team and the Shared Strategy for Puget Sound. It is the intent of the legislature that this new agency will define the actions necessary to restore and protect the health of Puget Sound. These actions are to become part of the agency's "Action Agenda", and are to be carried out by the year 2020. The Puget Sound Partnership is also charged with holding federal, state, and local agencies accountable for their commitments under the Action Agenda.

Recognizing the opportunity afforded by this new level of focus and coordination on Puget Sound issues, the Nearshore Partnership has pledged its support. A series of specific commitments were laid out by PSNERP in its response to the request of PSP staff for a scoping paper on nearshore issues. These include delivery of PSNERP technical products (change analysis, strategic needs assessment report) to help inform the Action Agenda. The goal of delivering an ecosystem restoration authority to the Puget Sound region via the GI study process is the most significant of potential contributions to the work of the Puget Sound Partnership.

The role of the Puget Sound Partnership in defining Washington state agency contributions and commitments is clearly described in its authorizing legislation. WDFW's has indicated appropriate response and support for PSP. PSP's relationship to federal agencies is emerging through a caucus of federal agencies aligned to support PSP (Puget Sound Federal Caucus). An MOU developed by the Federal Caucus outlines this support, signatories include USFWS and the Corps of Engineers.[5]

FWCA Consultation

Observations and Recommendations

Even as the program the mission and its integration expands, PSNERP continues to make good progress towards completion of the GI study. Program managers are striving to strike a balance towards long-term strategic planning and the immediate needs of the broad community of restoration practitioners working to protect and restore Puget Sound. During a period of tightening federal funding, the PSNERP GI continues to receive strong support from Congress and Corps of Engineers management.

[4] Engrossed Substitute Senate Bill 5372

[5] Federal Caucus signatories to the MOU are the Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, U.S. Fish and Wildlife, U.S. Geological Survey, the National Park Service, the Forest Service, Army Corp of Engineers, US Navy, US Army (Fort Lewis), Coast Guard, Natural Resource Conservation Service (USDA), Federal
Highway Administration.

The success of the program continues to derive from its focus on using the best available science. Analytical methods have been tested as pilot studies, evaluated by regional experts, and refined for Sound-wide application. PSNERP technical reports have been peer-reviewed prior to their publication. The Steering Committee and Project Management Team have responded affirmatively to the advice of the Nearshore Science Team in developing program peer review, which will be implemented by a panel of external science experts in FY 2008.

PSNERP also has an emerging focus on monitoring and adaptive management. In FY 2007, the program contracted with Battelle Marine Science Laboratory for the development of project-level monitoring guidance. This guidance will assist ESRP project proponents in developing monitoring programs that help advance the state of our restoration knowledge. The NST has defined this project-level guidance as its first step in developing broader programmatic level guidance and to the implementation of an adaptive management program for PSNERP.

While outside of the strict scope of the General Investigation study, USFWS appreciates the investment of program leadership in the effective implementation of ESRP. The program has made substantial investment in large-scale on-the-ground projects, including the Skokomish dike removal project, and more recently, the Nisqually National Wildlife Refuge restoration actions. This commitment to "learning by doing" while assisting regional salmon recovery and coastal ecosystem restoration efforts is strongly supported by USFWS.

Conclusions

The USFWS remains satisfied with the direction and progress of PSNERP. We continue to support the work of the Puget Sound Nearshore Partnership, as evidenced by our direct and in-kind contributions.

We are especially supportive of the emphasis placed on use of science in informing the GI and other Nearshore Partnership activities. Use of independent peer-review is particularly important to insure a strong technical approach and broad program credibility. Establishing an external science review panel consistent with NST recommendations should a primary area of focus for Project Managers in FY 2008. Next steps should include advancements in project monitoring associated with ESRP investments, and the development of an adaptive management framework for the entire program.

Finally, we strongly encourage the Nearshore Partnership to continue its cooperation with the emerging Puget Sound Partnership. The USFWS has committed its support to PSP, participating in the Puget Sound federal caucus, and representing Interior agencies on the PSP Ecosystem Coordination Board. This new state agency with a broad mandate of accountability represents a significant opportunity for improved coordination of agency activities, with measurable improvements in the health of Puget Sound.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

JAN 18 2011

Colonel Anthony Wright, District Commander
U.S. Army Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, WA 98124-3755

Dear Colonel Wright:

Enclosed is a Planning Aid letter summarizing the U.S. Fish and Wildlife Service's (USFWS) participation in the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) for Federal fiscal years 2009-2010. This Planning Aid letter is being submitted to fulfill commitments under the Fish and Wildlife Coordination Act (16 U.S.C. 661-667). This letter was prepared for the USFWS' Washington Fish and Wildlife Office by Curtis Tanner who coordinated USFWS support for PSNERP in FY 2009-2010.

The USFWS continues to support PSNERP as an activity that advances our Agency Mission. Successful completion of the PSNERP General Investigation (GI) is a priority for the USFWS, as evidenced by our on-going participation and in-kind contributions to the study. We encourage Program Managers to continue the strong emphasis on advancing a strategic, science-based approach to nearshore restoration and protection. The PSNERP results should be used to help inform both the large scale restoration and protection actions of Federal agencies, including the U.S. Army Corps of Engineers, as well as guidance for actions at more local scales.

Primary conclusions of this Planning Aid letter include:

- The importance of planning for integration of a Construction General into larger Puget Sound recovery efforts.
- Strong encouragement for continued collaboration with the Puget Sound Partnership, and support for Action Agenda implementation and revision.
- The need to continue to advance on-the-ground restoration efforts, including the Estuary and Salmon Restoration Program and Puget Sound and Adjacent Waters as the GI moves towards a Construction General authority.
- The broad applicability of PSNERP data and analytical methods, and the importance of their use beyond the GI.

TAKE PRIDE IN AMERICA

We look forward to continued USFWS involvement in, and support for the activies of PSNERP. Please contact Curtis Tanner at (360) 902-2815 or Mary Mahaffy at (360) 753-7763 if you have any questions related to this Planning Aid letter.

Sincerely,

for Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc:
Phil Anderson, Director
Washington Department of Fish and Wildlife

Bernard J. Hargrave, PSNERP Program Manager
Seattle District Corps of Engineers

Planning Aid Letter Attachment One:

Summary of FY 2009 – 2010 Fish and Wildlife Coordination Act Activities for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)

PSNERP Planning Aid Letter Attachment One

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Project Background

PSNERP General Investigation Study

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a large-scale, comprehensive initiative that affords a unique opportunity to tackle some of the foremost habitat restoration needs in Washington State's Puget Sound basin. Project goals are to identify significant ecosystem problems, evaluate potential solutions, and restore and preserve critical nearshore habitat. The PSNERP is a partnership between the U.S. Army Corps of Engineers (Corps) and local sponsors. The Washington Department of Fish and Wildlife (WDFW) represents the local project sponsors. Other major project partners contributing to this effort with direct and in-kind support include other state and Federal government agencies, Native American tribal governments, industries and environmental organizations.

The General Investigation Study (GI) will result in the identification of a portfolio of multiple large-scale ecosystem restoration actions. In completing the GI, the Corps is evaluating a broad range of alternative actions. Projects that best meet the Corps' criteria for implementation under an anticipated ecosystem restoration Construction General authority will form the basis for a request to Congress for authorization to implement priority actions. This will greatly enhance the combined capacity of Federal and State agencies, Tribal governments and others to protect and restore Puget Sound nearshore ecosystems.

As the Corps and its partners work towards completion of the GI, information being developed as part of the study is being delivered to assist on-going restoration programs and projects. This includes potential projects identified and evaluated by the GI, but not carried forward as part of the preferred alternative for implementation by the Corps. These actions will be shared with PSNERP partners for implementation through other programs and authorities to complement the work of the Corps. This dual focus of initiating large-scale strategic restoration actions and the support of more local scale projects makes PSNERP of particular interest to the U.S. Fish and Wildlife Service (USFWS).

U.S. Fish & Wildlife Service Participation

The USFWS Washington Fish and Wildlife Office (WFWO) continues its active involvement in, and support for, PSNERP. Our involvement carries out responsibilities of several WFWO program areas, including the Puget Sound Coastal Program, the Landscape Conservation Partnership Program and Division of Consultation & Technical Assistance Branch of Federal Activities. This Planning Aid Letter has been prepared as part of our Federal Activities duties as defined by the Fish and Wildlife Coordination Act (16 U.S.C. 661-667).

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USFWS Involvement in PSNERP Technical Teams and Governance

Nearshore Science Team

As with previous years dating back to the origins of the program, the USFWS has continued participation in PSNERP largely through the Nearshore Science Team (NST). Curtis Tanner, USFWS Coastal Program biologist, is a member of the NST, providing expertise in the field of habitat restoration to this interdisciplinary team. He has served in this role since Fiscal Year (FY) 2002. During this time his involvement has been cost-shared by the USFWS and the Corps. U.S. Army Corps of Engineers support is provided through an agreement under the Fish and Wildlife Coordination Act, USFWS funding is provided by the Coastal Program. This includes full participation in NST monthly meetings and associated responsibilities. During FY 2009-10, Curtis also had an active role in two PSNERP technical workgroups, the Strategic Needs Assessment Team and the Ecosystem Output Workgroup.

Implementation Team

In FY 2009, Ginger Phalen, USFWS Coastal Program Coordinator began to serve on the Implementation Team. In this capacity, Ginger has helped review Estuary and Salmon Restoration Program (ESRP) proposals. She has also contributed to other Implementation Team tasks, including the Management Measures Technical Report, and the evaluation of candidate actions for the PSNERP GI.

Steering Committee

In addition to his PSNERP activities supported by the Corps and the USFWS, Curtis Tanner also serves as PSNERP Local Project Manager under an agreement between USFWS and WDFW. The Local Project Manager and the Federal Project Manager (Bernie Hargrave, Seattle District Corps of Engineers) serve as co-chairs of the Nearshore PSNERP Steering Committee. While not directly represented on the Steering Committee, USFWS has determined that Curtis' involvement insures effective involvement in PSNERP program guidance. This issue is periodically revisited by USFWS management. Curtis' role as Local Project Manager is currently supported by an agreement between USFWS and WDFW through June 2011.

Executive Committee

During FY 2009-10, the USFWS continued its representation on the PSNERP Executive Committee by the WFWO Manager, Ken Berg. During this period, the Executive Committee did not meet. However, Mr. Berg has highlighted PSNERP during his discussions with other Federal agency leaders in the Puget Sound Federal Caucus. Mr. Berg also served on the Puget Sound Partnership (PSP) Ecosystem Coordination Board through FY 2010. In this role, he continued to advocate for PSNERP as a PSP Action Agenda priority.

Other U.S. Fish & Wildlife Service Support

Environmental Protection Agency Funding

In FY 2010, WFWO staff, led by Coastal Program Coordinator Ginger Phalen, prepared a proposal in response to an Environmental Protection Agency Request for Proposals for Puget Sound Scientific Studies and Technical Investigations. Through this process, the USFWS received funding to support PSNERP, providing its experience in coastal habitat restoration. For each of the candidate actions being evaluated by the PSNERP, the USFWS will complete Level 1 Contaminant Surveys and develop preliminary information to meet required compliance with Section 106 of the National Historic Preservation Act. For species listed under the Endangered Species Act, the USFWS will create and collate species lists, timing restrictions and best management practices for each candidate action. Funding for this work was received in September 2010, and the work is expected to be complete in March 2011.

Estuary and Salmon Restoration Project

The USFWS provided technical expertise and funding from both the Puget Sound Coastal Program and the National Coastal Wetland Conservation Grant Program. The USFWS Coastal Program staff coordinated with Washington State's Estuary and Salmon Restoration Program (ESRP) and other project partners on multiple nearshore conservation and restoration projects. Coastal Program staff participated in the ESRP project review and ranking team, provided Coastal Program funding and technical expertise and worked with local applicants to submit successful applications to the National Coastal Wetland Conservation Grant Program, which provides matching funds to ESRP. Examples of this successful partnership between the USFWS Coastal Program and ESRP include coordination, technical expertise, review and funding provided to the following large scale nearshore conservation and restoration projects: Smuggler's Slough Tidal Reconnection, Tarboo/Dabob Bay Acquisition, Fisher Slough Restoration, Nisqually Estuary Restoration, and the Lily Point Phase II Acquisition. The result is a partnership that supports conservation and restoration of over 1,560 acres of priority nearshore ecosystems and provided $4.2M of USFWS funding to support PSNERP and PSP goals and objectives. This partnership will continue in FY 2011, with Coastal program funding provided directly to 2010 ESRP ranked, priority projects.

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FY 2009 –2010 PSNERP Activities

Over the past two FYs (FY 2009-2010), the PSNERP Team of Project Managers, policy advisors, technical experts, and consultants have made considerable progress towards completion of the GI and delivery of a draft Feasibility Report. Numerous analyses referenced in earlier Planning Aid Letters have been completed, with technical reports either published, or near final. During this period, the project managers and staff have also successfully coordinated with the PSP, emerging as a priority action for the recovery of Puget Sound. In May 2010, the PSNERP successfully completed a formal review by Corps headquarters. This "Feasibility Scoping Meeting" is a significant milestone in the completion of a Corps GI, and marks the transition from evaluation of conditions and defining a problem of National significance, to the development of a feasible, cost-effective solution for potential implementation by the Corps. During this period, the PSNERP continued to maintain high standards of scientific integrity and quality of technical products.

External Peer Review and Stakeholder Involvement

Strategic Science Peer Review Panel

Consistent with the Nearshore Science Team's (NST) Peer Review Plan, Project Managers, in collaboration with the NST, convened a formal external peer review body. The Strategic Science Peer Review Panel (SSPRP) is comprised of six individuals from across the U.S. and Canada with a diversity of scientific expertise, and relevant experience in coastal/nearshore restoration. Members include:

- Denise Reed (SSPRP Chair). Professor, Department of Earth and Environmental Sciences, University of New Orleans.
- Maggi Kelly. Faculty Director for the Geospatial Imaging & Informatics Facility, College of Natural Resources, University of California, Berkeley
- Colin Levings. Scientist Emeritus Canada Department of Fisheries and Oceans and Adjunct Faculty, Institute for Resources, Environment, and Sustainability, University of British Columbia
- David Marmorek. President of ESSA Technologies Ltd, and Adjunct Professor, School of Resource and Environmental Management, Simon Fraser University
- Susan Peterson. Teal Partners, Rochester, MA.
- John Wells. Professor of Marine Geology, Director of the Virginia Institute of Marine Science and Dean of the School of Marine Science at the College of William and Mary.

The SSPRP convened its first meeting in June 2008. Following review of background materials and presentations on program research methods and results, particularly Change Analysis, the panel provided recommendations in five areas:

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- Problem Identification
- Program Vision
- Scientific Foundation
- Incorporation of Best-Available Science
- Gaps in Logic or Process

After reviewing these recommendations, the NST and the Project Management Team determined an appropriate response and responsible entity for addressing identified issues.

A second meeting of the SSPRP was held in May 2009. The second review meeting focused more directly on emerging PSNERP technical products and "in-progress" tasks. These included the Future Risk Assessment Project, Strategic Needs Assessment, Management Measures Technical Report, Science and Adaptive Management Plan, and Stakeholder Involvement Strategy. The SSPRP's second report organized recommendations in the following five areas:

- Identifying the Problem with Puget Sound Nearshore
- Strategic Restoration Portfolio Development
- Science, Technology, Monitoring and Adaptive Management
- Relationship to other Puget Sound Programs
- SSPRP Reporting and Feedback

The Project Management Team and NST members developed a response document to the second report, working with the SSPRP Chair to insure an appropriate approach to addressing issues raised by the Panel.

As a result of recommendations in the second SSPRP report, the NST prepared a science based problem statement based on Change Analysis and Strategic Needs Assessment conclusions. In October 2009, the SSPRP provided external peer review for the draft PSNERP Problem Statement.

In 2010, the SSPRP did not hold a "face to face" meeting, but collaborated via conference call and email to provide a review of the Draft Feasibility Report in December 2009/January 2011. The SSPRP reviewed the Draft Adaptive Science and Technology Plan in August 2010. Future SSPRP review tasks include the Strategic Needs Assessment Report (January 2011), Benefits Metrics (February 2011), and Puget Sound Nearshore Restoration and Conservation Strategies.

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Stakeholder Involvement Strategy

A recognized need for a more strategic and organized approach to stakeholder involvement, prompted in part by the SSPRP first Review, led to development of a formal plan. In December 2008, the Stakeholder Involvement Strategy was produced by a PSNERP Workgroup formed for this purpose. Development of the plan required close coordination with the PSP, which maintains a strong interest in public outreach. Major elements of the PSNERP Stakeholder Involvement Strategy include:

- Fostering Broad Program Understanding and Support
- Developing and Reviewing Restoration and Protection Goals and Objectives
- Involving Stakeholders in National Environmental Policy Act (NEPA)
- Developing and Advancing a PSNERP GI Project List

Associated tasks and budget were included in revising the PSNERP Project Management Plan. The Stakeholder Involvement Team has remained active, assisting in implementation of information meetings, fact sheet production, developing a standardized presentation for use by all PSNERP team members, and in NEPA Scoping Meetings.

National Environment Policy Act Scoping

In October 2009, activities to comply with NEPA were initiated by Program Managers. A formal Notice of Intent to prepare a Draft Programmatic Environmental Impact Statement was published in the Federal Register on October 2, 2009. The Notice of Intent established a written comment period from October 26 through December 10, 2009. Public notices were placed in 14 Puget Sound newspapers.

The PSNERP Stakeholder Involvement Team organized and facilitated NEPA Scoping meetings; all were sparsely attended despite email and print notifications:

- Des Moines, WA – 14 people in attendance
- Port Townsend, WA – 7 people in attendance
- Lacey, WA – 15 people in attendance
- Mount Vernon, WA – 24 people in attendance

Less than 40 comments were received, either in writing or verbally at the scoping meetings. In summary, NEPA Scoping generated limited public interest, and no controversial issues were identified.

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Program Management and Interagency Coordination

Project Management Plan Revisions

In January 2009 PSNERP Project Managers completed an extensive revision of the Project Management Plan (http://www.pugetsoundnearshore.org/program_documents/psnp_management-plan_vol1.pdf). Tasks defined generally in the original Project Management Plan were more completely described based on progress to date and an improved understanding of deliverables necessary to meet the Corps' feasibility study/decision document requirements. This increased level of detail allowed for an updated project budget and schedule.

Cost-Share Agreement Update

The Corps and WDFW Executives signed an amendment to the PSNERP Cost-Share Agreement in March 2009. Based on Project Management Plan revisions, it was agreed to increase the total cost of the GI Study from the original estimate of $12M to a revised estimate of $19.1M. Each party agreed to contribute up to $9.55M towards the cost of the study. Revision of the cost-share agreement insured continued progress towards completion of the GI as the original cost ceiling was approached by the parties.

Puget Sound Partnership Memorandum Of Understanding

In September 2009, the WDFW and the PSP signed a Memorandum of Understanding (MOU) regarding PSNERP. While the Corps was not a party to this agreement between State agencies, the clarification of relationships, roles, and responsibilities has had an important positive effect on the General Investigation. This includes sustained support for PSNERP, and prioritization of funding due to the role PSNERP serves to implement PSP's Action Agenda. The MOU addressed:

- Completion of the PSNERP General Investigation
- Coordination with the Federal government
- Stakeholder outreach and communication
- Relationship between PSP and PSNERP advisory and governance entities

Items pertaining to completion of the GI clearly communicate a shared interest in delivery of a draft Feasibility Report by the end of the State 2009-11 biennium (June 30, 2011). This has lead State managers to press for timely completion of the GI. Discussion of coordination partially shifts the funding burden from WDFW to a shared responsibility with PSP. Communication issues include changing the name from "Puget Sound Nearshore Partnership" to the original "Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)". Associated with this name change is direct affiliation of PSNERP with PSP as "the Nearshore Program of the Puget Sound Partnership". Sections

pertaining to Advisory and Governance Entities establish an important role for PSNERP in providing on-going technical support to nearshore restoration in Puget Sound. In summary, the PSP/WDFW MOU articulates PSNERP's responsibility in Puget Sound recovery efforts through its role in implementation of nearshore restoration.

Technical Studies and Deliverables

Draft Change Analysis Report

In July 2009, a first draft of the Change Analysis Report was completed. In October 2009, the draft Change Analysis report was submitted for peer review. In September 2010, a final version addressing peer review comments was completed. The document is currently being prepared for publication. Complete geospatial data used to conduct the PSNERP Change Analysis are available for download through the program website. Data are already widely distributed, and in-use by numerous entities beyond PSNERP. In FY 2012, the USFWS Coastal Program staff will be completing a strategic plan revision, and anticipate using PSNERP information to inform identification of program priorities.

The PSNERP Change Analysis provides a comprehensive, spatially-explicit analysis of net changes to nearshore ecosystems of Puget Sound since the period of early industrial development (c.a. 1850 to present). These observations provide indicators of qualitative change to nearshore ecosystem processes. Conceptual Models document assumptions regarding the relationship among nearshore ecosystem processes, structures and functions.

The PSNERP Change Analysis is intended to support the GI by informing restoration and preservation planning experts about the types, extent and consequences of changes to Puget Sound's shoreline. Additionally, the spatial geodatabase has been designed to accommodate future updates or expansions to datasets, providing a valuable tool to the Puget Sound nearshore management and restoration community.

Draft Strategic Needs Assessment Report

In September 2009, an initial draft of the Strategic Needs Assessment Report (SNAR) was completed by a team of NST, Implementation Team, and Contractors. The goal of this analysis was to characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the major problems contributing to the observed ecosystem degradation, and assess which of the causes are important to address through restoration and protection actions. The SNAR provides a more detailed evaluation of Change Analysis results, characterizing observed alterations of shoreline and watershed attributes to impacts on nearshore ecosystem processes. Stressors impacting nearshore ecosystem processes (e.g. tidal barriers, shoreline armoring, roads, and railroads) were evaluated in detail. Spatial distribution across Puget Sound, patterns of co-occurrence, and impacts on valued ecosystem components were described. Conceptual models documenting assumed relationships between stressors and ecosystem processes, structure, and function were developed. The SNAR established an analytical framework using

shoreline stressors to calculate metrics of process degradation. The information on degradation of ecosystem processes, as well as distribution of alterations documented in the Change Analysis Report, was used to identify major problems in Puget Sound nearshore ecosystems.

The Strategic Needs Assessment was revised following internal PSNERP team review, and a revised draft produced in January 2010. It was revised further to incorporate the results of the Future Risk Assessment Project, and to address comments raised by statisticians regarding the degradation metric calculation methods. A final draft for peer review was completed in December 2010.

Draft Future Risk Assessment Report

In October 2009, researchers at Oregon State University submitted the draft report "Envisioning Puget Sound Alternative Futures." Following PSNERP Nearshore Science Team review, a revised final report was completed in May 2010. The Future Risk Assessment Project (FRAP) was intended to help inform PSNERP project selection by identifying risk associated with future population growth in the Puget Sound region. The FRAP developed three scenarios of change:

1. Status Quo, reflecting a continuation of current trends in the region,
2. Managed Growth, reflecting the adoption of an aggressive set of land use management policies focusing on protecting and restoring ecosystem function and concentrating growth with Urban Growth Areas and near regional growth centers, and
3. Unmanaged Growth, reflecting a relaxation of land use restrictions with limited protection of ecosystem functions.

Analyses assumed a fixed population growth rate across all three scenarios, defined by the Washington Office of Financial Management. Using these population projections and rules defined by the three scenarios, the project modeled land use/land cover, shoreline modifications, and population projections over the next 50 years (2060). The project provided summary statistics describing landscape change variables for each sub-basin in Puget Sound, and was aggregated to provide Sound-wide results.

Information from FRAP has been used to develop indicators of future risk that inform restoration and protection strategies. As part of the Corps planning process, information from FRAP has also been used to define the "future without project" condition. Modeling of future land use changes, driven by projections of population growth, is used to evaluate changes in watershed conditions. A subset of nearshore stressors, were also modeled, allowing PSNERP to forecast patterns of continued nearshore ecosystem degradation.

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Problem Statement and Restoration Objectives

One of the primary recommendations of the second SSPRP report was development of a science based problem statement based on Change Analysis and Strategic Needs Assessment conclusions. In October 2009, the NST submitted a draft PSNERP Problem Statement for review to the SSPRP. A revised version addressing their comments was produced in August 2010, and received SSPRP support. A final version titled "*Degradation of Nearshore Ecosystem Processes in Puget Sound: Challenges for Restoration*" is now being prepared for layout and publication. A summary of the Problem Statement is also presented in the conclusion of the Strategic Needs Assessment Report.

The PSNERP Problem statement identified four major physical changes to Puget Sound's nearshore ecosystems:

1. There has been a dramatic loss of large river delta area, due primarily to barriers such as dikes that alter tidal hydrology. Much of the remaining large river delta area has been altered by shoreline armoring and other changes.
2. Many small, coastal embayments have been eliminated throughout Puget Sound or their connections to the Sound have been severed.
3. Impacts to beaches and bluffs, primarily as a result of shoreline armoring, have resulted in the loss of sediment supply and the interruption of sediment transport processes.
4. Estuarine wetlands have been extensively lost throughout Puget Sound. In particular, oligohaline and freshwater tidal wetlands have almost been completely eliminated.

This assessment also identified two major types of cumulative impacts associated with the interplay of these physical changes:

1. Puget Sound's shoreline has become shorter, simpler, and significantly more artificial since Europeans began settling the region.
2. Many places have experienced widespread, multiple, and compound changes. For example, armoring and roads often co-occur in the same place while some places that have experienced changes to the adjacent upland also experience changes directly on the shoreline.

These conclusions are documented through reference to Change Analysis and Strategic Needs Assessment results. The implications to biological resources are also documented where supported by empirical data.

These six major problems form the basis for defining PSNERP restoration and protection objectives. Definition of "planning objectives" is an essential step in the Corps planning process, by describing the desired results, and setting the stage for "plan formulation" and the identification of a preferred alternative for addressing the problems identified.

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The PSNERP restoration objectives, sub-objectives and associated metrics are described in detail in the draft Feasibility Report:

1. Restore connectivity and size of large river deltas
    a. Restore tidal flow in river deltas
    b. Restore wetland quality and quantity with emphasis on oligohaline and tidal freshwater
    c. Improve connectivity between the nearshore and adjacent uplands/watershed
    d. Increase the shoreline length of large river deltas

2. Restore sediment input, transport, and accretion processes
    a. Rehabilitate sediment input by reducing degradation of divergence zones and bluff-backed beaches

3. Restore shoreline complexity and length
    a. Restore shoreline length
    b. Restore embayments that have transitioned to artificial or have been lost
    c. Restore existing embayments

4. Enhance landscape heterogeneity and connectivity
    a. Restore richness of shoreforms
    b. Reduce fragmentation of the shoreline
    c. Improve connectivity between adjacent uplands and the nearshore

5. Protect relatively undegraded processes in large river deltas
    a. Preserve relatively intact deltas including adjacent upland areas
    b. Prevent further degradation of delta processes

6. Protect relatively undegraded sources of sediment
    a. Prevent degradation of divergence zones and bluff-backed beaches
    b. Protect bluff-backed beaches and divergent zones with minimal shoreline alterations

7. Protect relatively undegraded embayments
    a. Conserve areas of intact tidal flow
    b. Conserve areas of fewest shoreline alterations and least wetland area loss

8. Increase understanding of natural process restoration to improve effectiveness of project actions

In framing these restoration and protection objectives, the PSNERP Team has effectively linked observed changes in nearshore ecosystems, degradation of nearshore processes, major problems, and proposed solutions.

PSNERP Planning Aid Letter Attachment One

Management Measures Technical Report

A technical report describing 21 management measures available to restore and protect nearshore ecosystems was published in December 2009 following peer review. By relating actions to effects on nearshore processes, the Management Measures Technical Report (http://www.pugetsoundnearshore.org/technical_papers/management_measures.pdf) helps determine how to most effectively use the measures to accomplish process-based restoration in Puget Sound. The report:

- Provides an understanding of each measure's strengths, weaknesses and constraints.
- Provides the basis for describing proposed restoration actions for a development of a programmatic Environmental Impact Statement.
- Provides a systematic organizational framework for describing management measures that can be used to develop and evaluate site-specific restoration alternatives.

Appendices to the report pertaining to sea-level rise evaluate suitability of alternative sea-level rise scenarios for use by PSNERP, and provide a qualitative assessment of management measure vulnerability to sea-level rise.

Draft Feasibility Report

In December 2009, the PSNERP study team completed their first draft of a Feasibility Report for the General Investigation. This partial draft, prepared in advance of the Feasibility Scoping Meeting, describes the results of analysis to understand the magnitude and significance of nearshore ecosystem loss and degradation in Puget Sound, establishment of restoration objectives appropriate for the nature of the problem, and an approach to formulating a solution addressing these objectives. In short, this version provides the background necessary to describe a problem of National significance, stopping just short of defining a preferred alternative – this to be addressed in the final Feasibility Report.

In adherence to new Corps guidance for General Investigations, an Agency Technical Review was completed for the draft report by Corps subject matter experts outside of the Seattle District. The draft report was also reviewed by the PSNERP team, the Strategic Science Peer Review Panel, Seattle District Corps of Engineers staff outside of PSNERP, and Corps Regional Division staff. Following these reviews and subsequent revisions, the Draft Feasibility Report was submitted to Corps headquarters in March 2010.

Feasibility Scoping Meeting

The U.S. Army Corps of Engineers Headquarters review of the Draft Feasibility Report culminated in May 2010 with the completion of a Feasibility Scoping Meeting. The focus of this review and the Feasibility Scoping Meeting was policy compliance and technical sufficiency of the draft report. This review was successful, and in September 2010, the Seattle District received a Policy Guidance Memorandum from Corps headquarters. The memo documented compliance with Corps policy for the Draft Feasibility Report, and commended the PSNERP Team on the completeness of materials submitted for review. The Feasibility Scoping Meeting is a significant milestone in the completion of a Corps GI, and marks the transition from evaluation of conditions and defining a problem of National significance, to the development of a feasible, cost-effective solution for potential implementation by the Corps.

Candidate Projects List

In July 2010, the PSNERP Team completed an assessment of over 700 potential actions ("projects") identified by the Puget Sound restoration community – Lead Entities, Marine Resource Committees, non-governmental conservation organizations, state agencies and local governments, tribal governments, and others. This assessment of actions in the Nearshore Project Database focused on whether the collection of actions within a site, typically a process unit at the scale of drift cell or river delta, addresses the site needs defined by PSNERP analyses. For each site, the team evaluated all actions located within the site that employed the prescribed management measures. Actions were evaluated based on:

- Ability to restore target ecosystem process (e.g. tidal flow): was it the "right action/right place"?
- Appropriate spatial scale: taken together, were the proposed actions sufficient to address the identified sources of nearshore ecosystem process degradation?
- Landowner issues: did the action likely involve willing landowners and/or public ownership?

Initial results identified approximately 200 individual actions. In order to further refine the project list and complete the site selection process, a series of "Site Conversations" were arranged with sponsors of projects. The objective of site conversations was to collaborate with sponsors to identify candidate actions suitable to advance to development of conceptual design. In August 2010, the initial screening was completed, and a list of 52 actions was advanced for more detailed evaluation.

Conceptual restoration designs are currently being completed for these candidate actions. This information, anticipated in January 2011, will allow the PSNERP Team to assess cost-effectiveness of these potential restoration actions, and ultimately identify a tentatively selected plan (project list) to advance through the GI, seeking authority for Corps implementation.

PSNERP Planning Aid Letter Attachment One

Principles for Strategic Conservation and Restoration

In September 2010, following peer review and final revisions, PSNERP published "Principles for Strategic Conservation and Restoration" (http://www.pugetsoundnearshore.org/technical_papers/conservation_and_restoration_principles.pdf). This report summarizes principles of landscape ecology and conservation biology that are applicable to the conservation and restoration of nearshore ecosystems in Puget Sound. Principles were drawn from a scientific literature review of landscape ecology and conservation biology and are intended to guide the prioritization of sites and actions by PSNERP and others. The result is eleven principles derived from the literature organized into three hierarchical scales:

- Overarching Principles
- Landscape Level Principles
- Site-Specific Principles

These principles, available earlier in final draft form prior to publication, were used to help define strategies used for evaluation and selection of candidate actions.

Draft Adaptive Science and Technology Plan

The Strategic Science Peer Review Panel's second Report provided specific guidance in completing an Adaptive Management plan for the anticipated implementation phase of the Nearshore Project. In October 2010, a draft Adaptive Science and Technology Plan (ASTP) was submitted to the Strategic Science Peer Review Panel for their review and feedback. The Nearshore Science Team has received their comments, and is in the process of revising the ASTP to address this feedback.

The ASTP anticipates that an adaptive management framework will help to achieve maximum effectiveness of ecosystem restoration. Implementing this plan will benefit the broad community of restoration practitioners across the Puget Sound region by supporting a science partnership among Federal, State, local, and tribal governments that incorporates information gained through monitoring and adaptive management. It proposes to use both monitoring data and scientific investigation in collaboration among the non-Federal project sponsors and the Corps. Execution of the ASTP is intended to support the Construction General phase, including engineering and design of restoration actions, and to serve as a bridge between the planning of the GI and the implementation of the Construction General. A final version of the ASTP is anticipated in 2011.

FWCA Consultation

Observations and Recommendations

The Corps and their project partners continue to make good progress towards completion of the GI study. Concurrent with this progress are more immediate benefits of PSNERP

data, technical reports, and other tools to on-going restoration and protection efforts in Puget Sound. Program managers are succeeding in balancing long-term strategic planning, and the pressing needs of the broad community of restoration practitioners working to protect and restore Puget Sound. The PSNERP GI continues to receive strong support at the National level from Corps headquarters, and at the State level through its association with the PSP.

The success of the program continues to derive from its focus on using the best available science. Analytical methods have been substantially advanced and effectively applied over the past two years. The Program's commitment to both product-specific and programmatic peer-review helps insure on-going scientific integrity. This includes the establishment of the Strategic Science Peer Review Panel which has provided critical assessment of NST analyses and technical products.

As the GI moves towards successful delivery of a final Feasibility Report, the USFWS strongly encourages the Corps to plan for integration of a Construction General into larger Puget Sound recovery efforts. In particular, continued coordination with the PSP is essential to insure integration with regional efforts. Recently, the Seattle District Commander assumed a position on the PSP Ecosystem Coordination Board as one of three Federal agencies on this representative body. We anticipate that the Corps' new position on the Ecosystem Coordination Board will provide an opportunity for necessary coordination with on-going and future Puget Sound nearshore/coastal restoration and protection efforts.

The USFWS also encourages PSNERP partners, including the Corps, to apply emerging information and tools from PSNERP into other areas of nearshore restoration and protection. Recent discussions by the Puget Sound Federal Caucus on shoreline regulation and protection provide an example of forums where the use of PSNERP science and tools can be advanced.

While outside of the strict scope of the General Investigation study, USFWS appreciates the involvement of PSNERP technical and policy representatives in the effective implementation of Washington State's Estuary and Salmon Restoration Program. The application of PSNERP science in implementing on-the-ground restoration actions through the Estuary and Salmon Restoration Program serves to both advance strategic restoration in Puget Sound and to improve conditions benefitting fish and wildlife. This commitment to "learning by doing" while assisting Puget Sound recovery efforts is strongly supported by USFWS.

Similarly, the past two years has seen increased activity through the Corps §544 Puget Sound and Adjacent Waters authority. Qwuloolt Estuary Restoration is currently in advanced stages of planning, and anticipated for construction in 2011. The USFWS has had a long-term investment in this site, providing acquisition funds through the National Coastal Wetland Conservation Funds, and technical assistance through our Coastal Program. A Phase II project for Seahurst Park is also being advanced through the Puget Sound and Adjacent Waters authority, and would add an additional 1,200 feet of restored

shoreline to the 1,400 feet restored here in 2005. We encourage the Corps to continue to work with local sponsors to implement these projects in a timely manner, and to include monitoring and adaptive management as an essential element of project implementation.

Conclusions

The USFWS continues to support PSNERP as an activity that advances our Agency Mission. Successful completion of the PSNERP GI is a priority for the USFWS, as evidenced by our on-going participation and in-kind contributions to the study. We encourage Program Managers to continue the strong emphasis on advancing a strategic, science-based approach to nearshore restoration and protection for Puget Sound.

The USFWS stresses the importance of planning for integration of a Construction General into larger Puget Sound recovery efforts. An essential component of successful integration will involve continued collaboration with the PSP. Completion of the PSNERP GI has been identified in the PSP Action Agenda as a priority task. PSNERP can also provide information valuable in future revisions of the Action Agenda, and must transition from planning to implementation in the near future.

As the PSNERP continues to progress towards delivery of a Draft Feasibility Report, it is equally important to continue to advance on-the-ground restoration efforts. For PSNERP and the Corps, this includes the Estuary and Salmon Restoration Program and Puget Sound and Adjacent Waters. Finally, all PSNERP partners should recognize the broad applicability of PSNERP data and analytical methods, and the importance of their use beyond the GI. The Corps' other authorities for shoreline regulation, protection, and restoration, will benefit from applying the results of the GI.

DRAFT
Fish and Wildlife Coordination Act
Section 2(b) Report

Puget Sound Nearshore Ecosystem Restoration Project

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LIST OF ACRONYMS

APA	Agency Preferred Alternative
CAP	Continuing Authority Program
DPS	Distinct Population Segment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR/EIS	Integrated Feasibility Report / Environmental Impact Statement
FWCA	Fish and Wildlife Coordination Act
GI	General Investigation
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Acte
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PA	Preferred Alternative
PDT	Project Delivery Team
PMP	Project Management Plan
PSAW	Puget Sound and Adjacent Waters Restoration Program
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
RP	Recommended Plan
Service	United States Fish and Wildlife Service
USACE	United States Army Corps of Engineers
VEC	Valued Ecosystem Component

WDFW	Washington Department of Fish and Wildlife
WDE	Washington State Department of Ecology
WRDA	Water Resources Development Act

I. INTRODUCTION

The U.S. Army Corps of Engineers, Seattle District (USACE) is proposing to implement the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) in Puget Sound, Washington. Nearshore ecosystems have been severely degraded throughout Puget Sound and have been the focus of significant attention by federal, state, local, tribal, and private entities. Numerous species of anadromous fish, migratory birds, and other trust resources are dependent upon habitats provided by nearshore ecosystems. Western Washington tribes have asserted that habitat loss, including impacts to nearshore ecosystems, threatens salmon recovery efforts and the treaty protected rights that depend upon healthy salmon populations (NWIFC 2011). USACE proposes to implement a suite of actions to be delivered through PSNERP intended to restore ecosystem structure, function, and processes in Puget Sound for the benefit of native salmonids and other aquatic species.

USACE in coordination with local cost-share sponsors (State of Washington, represented by the Washington Department of Fish and Wildlife), stakeholders, and the U.S. Fish and Wildlife Service (Service), identified numerous potential restoration activities throughout the General Investigation (GI) study area. The study area encompasses the entirety of lower watersheds draining into Puget Sound including floodplains and river deltas (see Section II.B. for more detail) as well as the intertidal and nearshore subtidal shoreline of Puget Sound. USACE and their partners in the GI completed a comprehensive assessment of ecosystem conditions and nearshore habitat loss throughout the approximately 2,466 miles of Puget Sound shoreline (USACE 2014). This analysis informed the articulation of a problem statement and associated planning objectives to address observed patterns of ecosystem degradation. Approximately 700 restoration project concepts were evaluated against project objectives and ultimately 36 projects were carried through preliminary design and engineering. Subsets of these projects were used to define alternatives that are the subject of a Draft Integrated Feasibility Report / Environmental Impact Statement (FR/EIS) intended to represent the range of alternatives of a National Environmental Policy Act (NEPA) assessment. USACE in conjunction with local sponsors identified a recommended plan (RP) intended to represent the agency's preferred alternative (APA) of a NEPA assessment.

The purpose of this Fish and Wildlife Coordination Act (FWCA) Report is to evaluate possible effects to fish and wildlife of proposed PSNERP projects identified as the APA/RP. The report includes recommended actions for minimizing deleterious consequences and maximizing benefits. In doing so, this report broadly evaluates effects within the study area of each alternative in the FR/EIS in order to concur with or dispute selection of the APA/RP. The report concludes with an overall recommendation from the Service supporting the tiered approach to implementation of restoration projects proposed by USACE.

Our comments and recommendations have been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) (FWCA). This is a draft report and does not constitute the final report of the Secretary of the Interior required under Section 2(b) of the FWCA.

A. Coordination with Federal and State Agencies and Tribal Governments

Since the initiation of the GI in 2001 by USACE and the Washington Department of Fish and Wildlife (WDFW) stakeholder involvement and agency coordination have been vital components of PSNERP. A multi-disciplinary, multi-agency Project Delivery Team (PDT) has supported USACE and WDFW with development and execution of all aspects of the GI. The PDT comprises six standing teams with agency, non-governmental organization and other representatives serving on the Executive Committee (EC), Steering Committee (StC), Project Management Team (PMT), Nearshore Science Team (NST), Implementation Team (IT), and Stakeholder Involvement Team (SIT). A comprehensive list of PDT composition and affiliation, including Service participation, is provided in the FR/EIS (USACE 2014).

USACE has engaged in formal and informal coordination with the federally recognized tribes of the Puget Sound throughout the feasibility phase. In addition to direct tribal coordination the PDT has also included representation from the Northwest Indian Fisheries Commission. Coordination with tribes is ongoing and USACE will continue to offer opportunities to meet informally or through government-to-government meetings. Most recently USACE has met with tribes most directly affected by proposed projects. Tribal coordination will continue throughout the feasibility phase, preconstruction engineering and design, and construction.

Many project partners, the Washington State Governor, and five members of Congress have provided letters that express their support for PSNERP.

B. Project Authority, Purpose, and Scope

Proposed actions are the outcome of the Puget Sound Nearshore Ecosystem Restoration Study, which USACE is conducting under the authority of the River and Harbor Act of 1962 (Public Law 87-874). USACE initiated the reconnaissance phase in September 1999 and determined that there was sufficient federal interest to advance to the next stage of conducting GI. WDFW, as the non-Federal sponsor, and USACE initiated the feasibility phase of the study on September 25, 2001.

The purpose of the GI was to evaluate ecosystem degradation in the Puget Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend sites that have a Federal interest and the support of a local entity willing to provide necessary local cooperation. The Puget Sound Nearshore Study aims to address the continuing degradation of nearshore ecosystems through restoration of natural processes (e.g. sediment movement and tidal hydrodynamics) and restoration of coastal wetlands, embayments, and beaches.

The PDT identified three goals for restoration of the Puget Sound nearshore zone:

- Restore and protect nearshore processes that sustain the ecological health of Puget Sound;
- Restore and protect ecosystem functions and structures that support valued ecosystem components (VECs); and
- Increase understanding of the Puget Sound nearshore zone to improve restoration and protection actions.

C. Prior Efforts and Coordination with the Service

USACE initiated consultation with the Service under FWCA in 2002, shortly after the start of the GI Feasibility Phase. The Service has provided three Planning Aid Letters (2005, 2007, and 2011) and provided a Service biologist to be a member of the NST and the StC. The Service has been supportive of Nearshore Study efforts and USACE has been incorporating Service technical advice into project planning, strategies, objectives, site screening, and conceptual designs.

A Service report (USFWS 2011) supporting the formulation of a Nearshore Study preferred alternative includes information on federally listed threatened or endangered species under the Endangered Species Act (ESA) for each of the 18 sites evaluated. In our report the Service provided a species list and a species-specific and general conservation measures from the Programmatic Biological Assessment and Biological Opinion for Fish Passage and Restoration Actions in Washington State (NMFS and USFWS 2008). USACE, NMFS, and the Service are revising this programmatic consultation to cover all types of actions proposed by the Nearshore Study team with expected completion in 2016.

D. Prior Studies and Reports

USACE has conducted other GIs and has implemented other ecosystem restoration projects around Puget Sound prior to initiating the Puget Sound Nearshore Study (see Tables 1.7.1 and 1.7.2 from USACE 2014). These include the Puget Sound and Adjacent Waters Restoration Program (PSAW) which was authorized by §544 of the Water Resources Development Act (WRDA) of 2000. While this authority has not been fully utilized due to the lack of a supporting GI, directed funds have been used to implement several nearshore restoration projects. Projects implemented under PSAW include the Qwuloolt ecosystem restoration project and Seahurst Beach restoration Phases 1 and 2. PSAW authorization includes an upper limit of $40M in federal funding available through the life of the authority and per-project caps ($5M federal funding). Projects proposed under PSNERP would exceed these limits thus rendering PSAW insufficient to meet the needs identified by the PSNERP GI. Similarly, Corps of Engineers Continuing Authorities Programs (CAPs), including §1135 of WRDA 1986 and §206 of WRDA 1996, have been used to implement smaller restoration projects in Puget Sound and contributing watersheds. These programs are also constrained in their ability to deliver large-scale restoration actions proposed by PSNERP with limits on per-project federal funding.

In support of the GI PSNERP produced 24 peer reviewed technical reports. These reports documented study approach and results as well as establishing the conceptual framework upon which this ecosystem approach to restoration was based. Documents can be accessed on the program's website: http://www.pugetsoundnearshore.org/technical_reports.html.
A subset of these technical reports forms the basis for the USACE definition of planning objectives and project selection strategy, and is highlighted in the Chapter 12 of the FR/EIS (Annotated Bibliography). These principal PSNERP technical reports include:

> *Principles for Strategic Conservation and Restoration.* This report summarizes principles of landscape ecology and conservation biology that are applicable to the conservation and restoration of nearshore ecosystems in the Puget Sound and are

intended to guide the prioritization of sites and actions by the PDT and others (Greiner 2010).

Historical Change and Impairment of Puget Sound Shorelines: Atlas and Interpretation of Puget Sound Nearshore Ecosystem Restoration Project Change Analysis. This report is a comprehensive, spatially-explicit analysis (Change Analysis) of net changes to nearshore ecosystems of Puget Sound—its beaches, estuaries, and deltas—since its earliest industrial development. This Change Analysis report provides the spatially explicit analysis that identifies impacts to Puget Sound. These data were used to both quantify Sound-wide conditions and identify site-specific restoration needs and opportunities (Simenstad *et al.*, 2011).

Implications of Observed Anthropogenic Changes to the Nearshore Ecosystems in Puget Sound. This report presents a synthesis of the most significant physical changes to the nearshore ecosystems of Puget Sound and implications of these changes to ecosystem functions, goods, and services. This document served as the basis for definition of the Problem Statement for PSNERP and the rationale for ecosystem restoration objectives (Fresh *et al.*, 2011).

Strategies for Nearshore Protection and Restoration in Puget Sound. This report presents a model for integrating change analysis and estimating ecosystem degradation. This model is applied to evaluate potential delta, beach, barrier embayment, and coastal inlet restoration sites (Cereghino *et al.*, 2012)

The basis for design concepts and initial engineering for a suite of 36 potential nearshore restoration projects is presented in a contractor's report to the study: *Strategic Restoration Conceptual Engineering — Final Design Report* (ESA 2011), also available on the program website: http://www.pugetsoundnearshore.org/cdr.html

There is also a series of four documents produced by the Service with contractor support to supplement Nearshore Study conceptual design work and includes the following:

PSNERP Strategic Restoration Conceptual Design Preliminary Environmental Contaminants, Cultural Resource, and Endangered Species Site Evaluations. This report provides baseline information on environmental contaminants, cultural resources, endangered species, and conservation measures for 36 candidate restoration sites under consideration by the Nearshore Study team. Environmental Site Assessment Level 1 Survey Checklists were also completed for each of the 36 sites (USFWS 2011).

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington, Task - Literature and Data Review and Synthesis. This report presents the results of cultural resource record/literature searches for 36 candidate restoration sites under consideration by the Nearshore Study team. An assessment of the potential for cultural resources within each project area is made based on a review of the environmental, cultural, and archaeological data. Recommendations

are provided on where future archaeological efforts should be made for each of the 36 areas of potential effect.

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington - Task 2: Historic Context of Agricultural Dikes. This report is a regional-scale historic context of late nineteenth and early twentieth century agricultural development within the Puget Sound region of northwest Washington. This report documents the history of development of dikes built in the region, and proposed evaluation criteria to use as a management tool for Service and others to use for future compliance with Section 106 of the National Historic Preservation Act.

Cultural Resources Field Inventory for 15 Action Areas within the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington. This report presents the findings of both surface surveys and subsurface investigations concentrated on project components within areas previously determined to have high to moderate probabilities for cultural resources. The purpose of the inventory was to provide (1) descriptions of cultural resources in the area of potential effect (APE) for Nearshore Study undertakings, (2) determinations concerning the eligibility of cultural resources to the National Register of Historic Places (NHRP) and the Washington Heritage Register (WHR), and (3) recommendations on how to avoid or mitigate impacts to historic properties. This report was completed for subset of the 36 candidate restoration sites and only on lands where access had been granted by the landowner.

DRAFT

II. DESCRIPTION OF STUDY AREA AND ACTION AREA

A. Puget Sound Context

The waters of Puget Sound cover nearly 17,000 square miles, a watershed collectively referred to as the Puget Sound Basin. This basin is bordered on the east by the Cascade Mountains and on the west by the Olympic Mountains. The Puget Sound Nearshore Study area consists of the nearshore zone of the Puget Sound Basin including Puget Sound, the Strait of Juan de Fuca, and southern portions of the Strait of Georgia that occur within the borders of the United States (Figure 1). Headwaters for two of these basins originate just north of the border in Canada. The study area shoreline is approximately 2,466 miles in length. The basin is roughly 80 percent land and 20 percent water. The total water area covers nearly 3,090 square miles at mean high water. The region's soils are characterized as immature, being less than 10,000 years old. Typical of fjords, water depths in Puget Sound increase rapidly from shore, with an average depth of 200 feet and a maximum depth of more than 1,200 feet. (USACE 2014).

The structures and habitats of Puget Sound are a complex mixture of beaches and bluffs, estuaries, lagoons, river deltas, and rocky coastlines. Shipman (2008) defines a classification of Puget Sound nearshore landforms that reflects the primary role of geomorphic processes in shaping the landscape. This classification system identifies four geomorphic systems that form the foundation of this shoreline classification. Three of these systems (beaches, embayments, and river deltas) reflect differences in the roles of waves, tides, and rivers in transporting sediment and shaping the coastline. The most common Puget Sound shoreline type consists of mixed sand and gravel beaches backed by high coastal bluffs. Other sediment dominated shoreline environments include large river deltas, tidal flats, salt marshes, and estuaries. A fourth system, rocky coasts, is characterized primarily by the limited availability of mobile sediment and the lack of major depositional landforms. Rocky-bottom habitat is less common than soft-bottom habitat and is confined mostly to northern Puget Sound. The shorelines of the San Juan Islands exemplify rocky coast systems in Puget Sound (Shipman, 2008).

Widely varying fish communities utilize Puget Sound nearshore ecosystems where individuals spend all or portions of their lives. In general they are grouped as demersal/reef fish, forage fish, and anadromous fish. Fifteen native species of anadromous fish use marine and freshwater habitats of the Puget Sound area. These include all five species of Pacific salmon (pink - *Oncorhynchus gorbuscha*, coho – *O. kisutch*, chum – *O. keta*, Chinook – *O. tshawytscha*, and sockeye – *O. nerka*), two species of native char (bull trout - *Salvelinus confluentus* and Dolly Varden – *S. malma*), steelhead (*O. mykiss*) and coastal cutthroat trout (*Oncorhynchus clarkii clarkii*), longfin smelt (*Spirinchus thaleichthys*), eulachon (*Thaleichthys pacificus*), white (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*), and Pacific lamprey (*Entosphenus tridentatus*) and river lamprey (*Lampetra ayresii*). Numerous anadromous fish populations are listed as threatened or endangered under the ESA in Puget Sound, with habitat loss cited as a threat limiting species recovery.

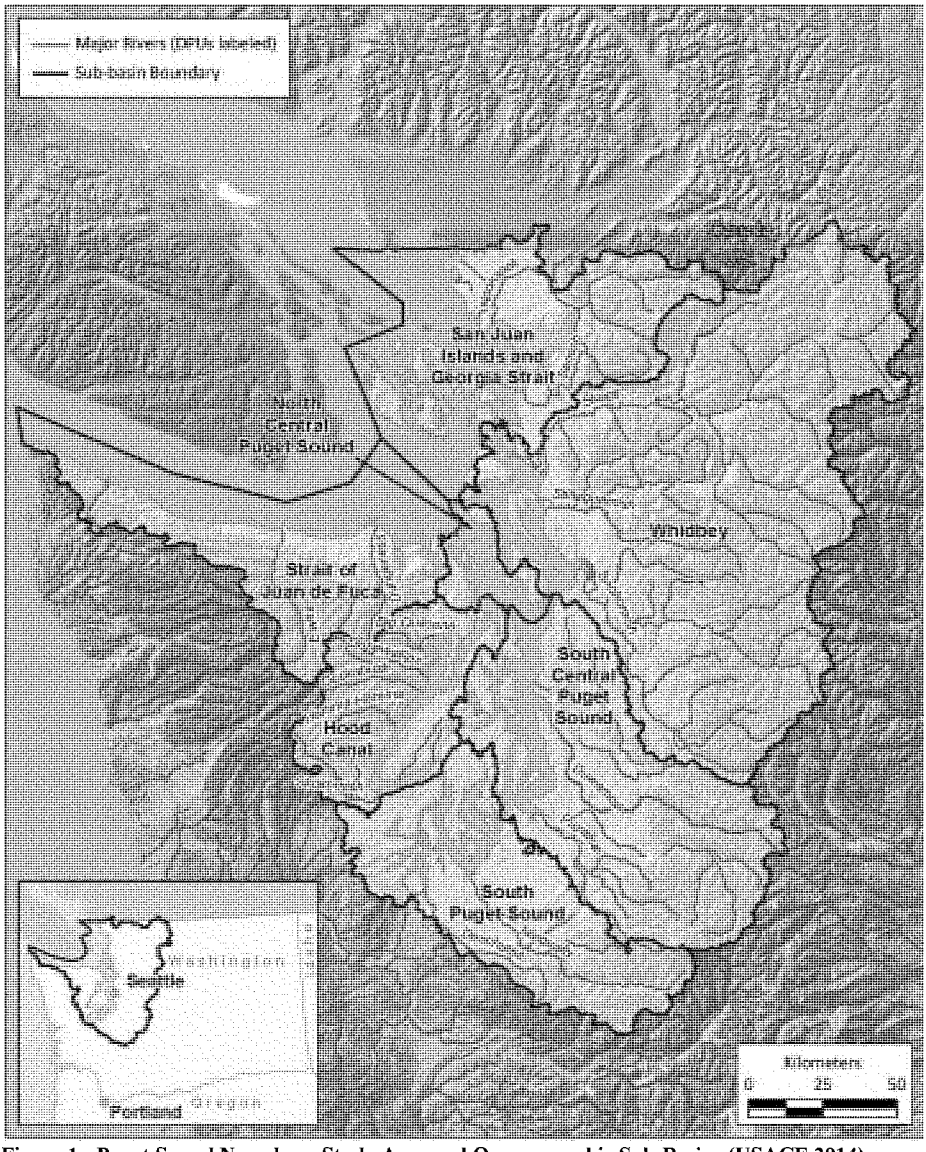

Figure 1: Puget Sound Nearshore Study Area and Oceanographic Sub-Basins (USACE 2014).

B. Study Area and Action Area

For the purpose of this project the study area has been divided into seven sub-basins based on geographic features including oceanographic sills and bathymetry, common issues and interests of the entities in these areas, and water flow patterns (Figure 1). Generally consistent with other delineations of greater Puget Sound, these sub-basins include:

- Strait of Juan de Fuca
- San Juan Islands – Georgia Strait
- Hood Canal
- North Central Puget Sound
- Whidbey
- South Central Puget Sound
- South Puget Sound

Five of these sub-basins are included within the watershed area of Puget Sound proper. The other two study area sub-basins include areas of the Strait of Juan de Fuca and the Georgia Strait seaward to the international boundary. Within these sub-basins, the study area consists of the entire extent of the nearshore zone, which includes beaches and the adjacent tops of coastal banks or bluffs, the shallow waters in estuarine deltas, and tidal waters from the head of tide to a depth of approximately 10 meters relative to the mean lower low water (MLLW) level (Figure 2). This contiguous band around the shoreline of the entire study area hosts diverse ecosystems that are shaped by coastal geomorphology and local environmental conditions, such as wave energy and salinity.

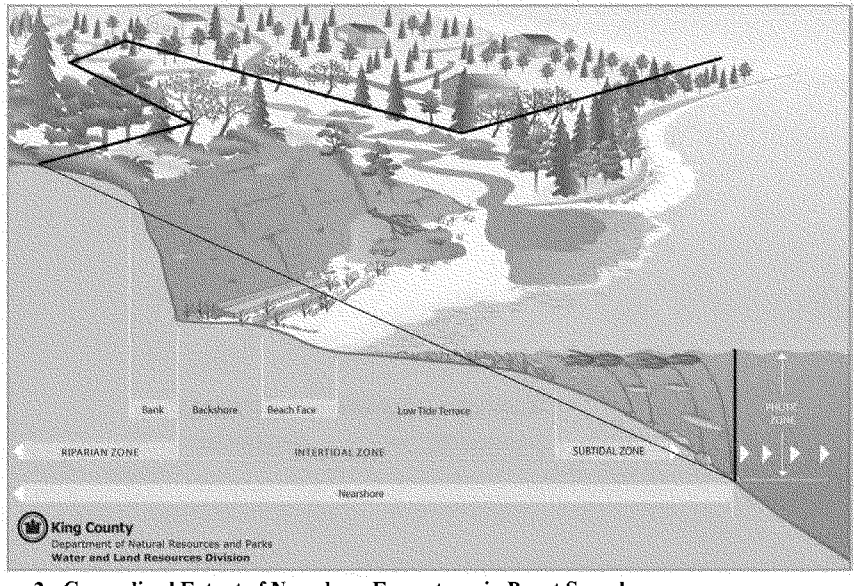

Figure 2: Generalized Extent of Nearshore Ecosystems in Puget Sound.

III. FISH AND WILDLIFE RESOURCES AND PLANNING OBJECTIVES

A. General Fish and Wildlife Concerns

Led by an interdisciplinary Nearshore Science Team, USACE, WDFW, and other project partners completed a comprehensive, spatially explicit assessment of the extent of change throughout Puget Sound's shorelines, estuaries, and deltas. This Change Analysis (Simenstad *et al.*, 2011) quantified structural and physical change between historical (ca. 1850s – 1890s) and current (ca. 2000 – 2006) conditions along the entire 2,466 miles of Puget Sound shoreline and corresponding 13,930 square miles of drainage area. Observed changes were subsequently analyzed to characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed in this feasibility study through restoration and protection alternatives (Schlenger *et al.*, 2011a). Conceptual models were used to connect alterations of critical ecosystem processes and the resulting habitat loss to a representative subset of socially relevant fish and wildlife resources referred to as "valued ecosystem components" (VEC's). A series of white papers authored by species experts summarized scientific literature documenting these species/habitat relationships for VEC's, including:

- Kelp and eelgrass (Mumford 2007)
- Marine riparian vegetation (Brennan 2007)
- Native shellfish (Dethier 2006)
- Forage fish (Penttila 2007)
- Juvenile salmon (Fresh 2006)
- Orca whales (Kriete 2007)
- Nearshore birds (Buchanan 2006)
- Great blue herons (Eissinger 2007)

Integration of these observed changes in nearshore ecosystem, identification of fundamental causes of degradation, and documented species/habitat relationship provided the technical basis for the definition of a problem statement. In the USACE planning process followed in the GI study, an understanding of ecosystem problems leads to establishment of planning objectives, against which restoration opportunities can be evaluated for effectiveness, efficiency, and feasibility. The problem statement defined by the Nearshore Science Team for the study is summarized by Fresh *et al.*, (2011):

1. Large river deltas have been widely impacted by multiple alterations that significantly limit the size of the estuaries and degrade the nearshore ecosystem processes that support them.
2. Many coastal embayments, including open coastal inlets, barrier estuaries, barrier lagoons, and closed lagoons/marshes, have been eliminated or disconnected from Puget Sound by the placement of fill, tidal barriers, and other stressors.
3. Stressors along beaches and bluffs have disconnected sediment inputs and altered sediment transport and accretion along long sections of the Puget Sound shoreline.

4. Estuarine wetlands have been extensively lost throughout Puget Sound including a loss of 56% in the 16 largest river deltas. In particular oligohaline and freshwater tidal wetlands have been almost completely eliminated (loss of 93%) in Puget Sound.
5. The shoreline of Puget Sound has become much shorter and simpler, as well as more artificial. Since Europeans began settling the region, Puget Sound's shoreline has had a net decline of 15% in length. Artificial landforms now represent 10% of the shoreline of Puget Sound.
6. Large portions of Puget Sound have been altered by multiple types of changes that may cumulatively combine to severely degrade nearshore ecosystem processes. Approximately 40% of the shoreline of Puget Sound has been altered by one or more stressor (e.g., overwater structures, roads, marinas, fill, armoring etc.).

1. Large River Deltas

PSNERP study documents conclude that barriers to tidal hydrology and shoreline armoring were the primary stressors impacting river delta ecosystems in Puget Sound. All of the 16 largest deltas of Puget Sound have been extensively modified with an estimated total loss of shoreline of 109 miles or 27% from historical conditions. Changes to the wetlands of the large deltas have been especially dramatic. In aggregate 56% of the historical wetlands (57,823 acres) of Puget Sound river deltas have been eliminated (Simenstad *et al.*, 2011).

USACE (2014) notes that these impacts have diminished the availability of habitat for numerous plant and animal species. Shorebirds that utilize estuarine tidal flats for feeding, roosting and reproduction have been adversely impacted by loss of river delta habitats (Buchanan 2006). Diking and filling of delta ecosystems has decreased tidal channel habitat, restricting fish and wildlife to less area. The Duwamish and Puyallup estuaries have been simplified to a single channel, concentrating fish, limiting ability to avoid predation, and reducing overall carrying capacity. While less severe than these urban estuaries, all large river deltas elsewhere in Puget Sound have been similarly degraded with the simplification of historically complex and dynamic tidal channel systems.

2. Coastal Embayments

Throughout Puget Sound small coastal embayments have been eliminated by filling or have been disconnected from the nearshore zone by fill causeways, tide gates, or diversions. PSNERP analysis mapped the location of 884 historical embayments. The current condition includes 579 mapped embayments, a net loss of 305 of these critical "pocket estuaries" in Puget Sound. Embayments historically accounted for 689 miles of Puget Sound shoreline (23%) but now account for 375 miles of shoreline (15%); this represents a decline in length of 46%. Many remnant embayments have been modified, reduced in area by encroaching fill or impacted by shoreline armoring. Approximately 18% of the remaining shoreline associated with coastal embayments is armored (Simenstad *et al.*, 2011).

The sheltered condition of embayments makes them important habitat for native shellfish, fish, and shorebirds. Embayments provide cover and a food-rich environment for several species of juvenile fish during their migration along the shore from natal streams to the Pacific Ocean. Recent evidence from the Whidbey Sub-basin shows that large numbers of post-larval and

juvenile surf smelt rear in "pocket estuaries" (Beamer *et al.*, 2006). During late winter and early spring large numbers of juvenile Chinook and chum salmon rear in pocket estuaries of the Whidbey Sub-basin.

3. Beach and Bluff Systems

Puget Sound beaches have been broadly impacted by modifications with armoring (seawalls and revetments) observed as the most pervasive direct alteration. Armoring occurs along one-third of bluff-backed beaches and over a quarter of barrier beaches; 34% of all bluff-backed beaches are armored along more than half of their length. Only 25% of all bluff-backed beaches are completely unarmored. The distribution of armoring associated with beaches varies greatly among sub-basins with nearly 63% of the shoreline armored along the highly developed shores of south central Puget Sound between Tacoma and Everett. In addition to armoring, roads and nearshore fill are the most significant stressors affecting beaches in Puget Sound (Schlenger *et al.*, 2011a)

Shoreline armoring and other changes to beaches and bluffs have resulted in the loss of sediment supply (sand and gravel). The resulting interruption of sediment transport processes has impacted beaches and increased vulnerability to wave erosion and changes in sea level. Disruptions in sediment processes can also change the physical characteristics of a beach, including changes in sediment composition (e.g. coarsening), steepening of beach slopes, and narrowing of beach width (Shipman *et al.*, 2010). These changes decrease the quantity of beach habitat available, and sediment composition changes can lead to decreased availability of fine grained substrates needed for shellfish, probing shorebirds, and beach-spawning fish.

In addition to loss of fine-grained material that beach-spawning fish require, armoring can affect reproduction of forage fish in several ways. Armoring low in the intertidal zone can directly eliminate the spawning habitat of several species (e.g. surf smelt and sand lance) that spawn on the upper beach (Penttila, 2007). Armoring can also increase sediment temperatures on the upper beach where shading by natural shoreline vegetation has been removed; reducing survival of incubating embryos (Rice, 2006). In addition to effects on reproduction of forage fish armoring can affect feeding behavior of juvenile forage fish (as well as juvenile Pacific salmon) that often feed in shallow water at high tide. When shoreline modifications extend lower on the shore the truncation of intertidal shallow water habitat by armoring reduces foraging by juvenile fish on riparian insects (Toft *et al.*, 2007).

4. Estuarine Wetlands

Eighty percent of historic Puget Sound estuarine wetlands were associated with the 16 large deltas; the remainder were associated with embayments. Historically delta system wetlands supported nearly 103,000 acres of estuarine wetlands compared to the current 45,220 acres, a decline of 56%. Coastal embayments have been similarly impacted with a loss of 69% of historic wetlands; only 8,229 acres remain. Tidal freshwater and oligohaline transitional wetlands (i.e. tidal forests and swamps) have been nearly eliminated; over 90% of these two wetland types have been lost throughout Puget Sound (Simenstad *et al.*, 2011). Based on land cover projections from Bolte and Vache (2010) losses of tidal wetlands are expected to continue.

5. Shoreline Simplification

The shoreline of Puget Sound has become shorter and simpler (i.e. straighter, less complex) over the past 150 years. Throughout the Puget Sound basin the net loss of shoreline length has been 431 miles, resulting in a current shoreline that is about 15% shorter than it was historically. While more than 600 miles of natural shoreline was eliminated, 229 miles of artificial shoreline (i.e. seawalls backed by fill) was added. Although the length of shoreline classified as artificial was negligible historically artificial shoreline built by a modern industrial society now represents about 10% of the total length of shoreline in Puget Sound (Simenstad *et al.*, 2011).

6. Cumulative Effects

Many of the altered shoreline segments around Puget Sound have not just one, but multiple types of human-caused alterations. Only 14% of the project area is not impacted by a shoreline stressor. Of the nine shoreline stressors considered in the Nearshore Study armoring is clearly the dominant stressor, occurring in 78% of all shoreline segments analyzed. Although no shoreline segment was impacted by all nine stressors, 81% of segments have more than one type of stressor. It is highly likely that cumulative effects are negatively affecting nearshore ecosystem functions (Simenstad *et al.*, 2011).

B. Planning Objectives

Based on the analysis described above and in direct response to the identified problems of observed nearshore ecosystem degradation, the study team developed four planning objectives with associated sub-objectives to guide the formulation of alternative plans (USACE 2014). The planning objectives articulate the goal of PSNERP to restore the physiographic processes that sustain the Puget Sound nearshore ecosystem and its broad array of nationally and regionally significant resources. Through process restoration the project aims to sustainably address impairment to the nearshore zone's ability to deliver ecosystem functions, goods, and services, and to support valued ecosystem components. Planning objectives most directly address the first three problem statements described above and indirectly address the others. The planning objectives are:

1. Restore connectivity and size of large river delta estuaries.
2. Restore the number and quality of coastal embayments.
3. Restore the size and quality of beaches.
4. Increase understanding of natural process restoration in order to improve effectiveness of project actions.

C. Current Status of Fish and Wildlife Resources

1. Federally Listed Species

In coordination with the Service, USACE has identified 13 fish and marine mammal within the study area listed as threatened or endangered under the Endangered Species Act. Information

provided by the Service was used by USACE to analyze potential impacts for proposed restoration actions (USFWS 2011). Recovery plans for eight of the ESA-listed species have been or are being developed by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service. Actions proposed by the Nearshore Study support salmon recovery consistent with NOAA's salmon recovery plans.

Federal ESA-listed species and/or the habitat suitable to support these species which may occur in the study area include the following:

- Bocaccio
- Canary rockfish
- Yelloweye rockfish
- Eulachon
- Hood Canal summer chum salmon
- Puget Sound Chinook salmon
- Coastal/Puget Sound bull trout
- Puget Sound steelhead trout
- Green sturgeon
- Southern resident killer whale (Orca)
- Humpback whale
- Marbled murrelet
- Golden paintbrush

Information on listing status, use of the nearshore zone of Puget Sound, and factors that have led to their decline is presented in the FR/EIS and discussed in further detail in supporting documents, including *Appendix F: Supplemental Information on the Affected Environment* (USACE 2014). Pertinent information for these ESA listed species is summarized below.

a. Boccacio, Canary, and Yelloweye Rockfish

Bocaccio (*Sebastes paucispinis*) are a rockfish species that range from northern British Columbia to central Baja California. Pelagic juveniles are known to occur along margins of nearshore ecosystems containing rocky substrate with kelp or sandy areas supporting eelgrass. Primary threats are associated with adult mortality from direct fishing and bycatch of this long-lived species. Overharvest led to recruitment failure in the early 1900s. Due to declining numbers and increased rarity, bocaccio is ESA-listed as endangered (NMFS 2009).

Canary rockfish (*Sebastes pinniger*) range from northern British Columbia to northern Baja California. Yelloweye rockfish (*Sebastes ruberrimus*) have an overlapping range with a slight northward shift in distribution from the eastern Aleutian Islands to Northern California. Both species can be very long-lived, with adult canary rockfish potentially living to be 80+ and yelloweye rockfish slightly longer. Adult canary rockfish occupy relatively deep marine environments, observed in depths of 250 to 650 meters in areas with considerable current around pinnacles and high relief rock. Yelloweye rockfish are associated with somewhat shallower, similar rocky marine areas with refuge such as crevices, caves, and boulder piles. Occasionally

they will wander onto mudflats adjacent to rocky areas in shallower waters. As with boccacio, juveniles are pelagic drifting with coastal currents over nearshore areas. Both rockfish species are ESA-listed as threatened due to declining numbers and increased rarity. Threats to these species of rockfish are the same as those for bocaccio. There are no Federal recovery plans for these three species of rockfish. WDFW has a Rockfish Conservation Plan that focuses on managing fisheries, establishing marine conservation areas, reporting and removing fishing gear, and exploring hatchery program and artificial reefs. They also publish recommendations to limit bycatch and mortality from recreational angling (WDFW 2012).

b. Eulachon

Eulachon (*Thaleichthys pacificus*) are a small anadromous fish that range from California to Vancouver Island including northern Puget Sound. Threats to eulachon include habitat loss and degradation of spawning grounds via dams, siltation, and dredging, and potentially chemical pollution (Gustafson *et al.*, 2010). The southern Distinct Population Segment (DPS) of eulachon is ESA-listed as threatened (NMFS 2010). There are no formal recovery plans for eulachon.

Eulachon spend most of their lives in the nearshore zone before migrating into the major river systems along the west coast of North America to spawn in the early spring (late February to May). No spawning areas are documented in Puget Sound. The only documented eulachon spawning near the project area is the Elwha River in the Strait of Juan de Fuca (designated as critical habitat) (NMFS 2011). It is believed that eulachon return to the estuary of their birth but it is not known if they return to the same river from where they hatched. After hatching larvae are carried downstream and out into the estuary where they feed on zooplankton.

c. Hood Canal Summer Chum Salmon

Chum salmon (*Oncorhynchus keta*) range from Monterey, California to the Arctic coast and Beaufort Sea along the west coast of North America. While chum stocks in greater Puget Sound are relatively stable six of the eight summer chum salmon stocks within the Hood Canal Evolutionarily Significant Unit (ESU) were decreased in abundance with return stocks below viable replacement levels in the early 1990's (Fresh 2006). Threats to Hood Canal summer-run chum salmon include nearshore habitat loss and degradation, harvest, and low water flows in Hood Canal watersheds (Johnson *et al.*, 1997). Based on declining run sizes and threats to continued survival of this unique run the Hood Canal summer-run chum salmon Evolutionarily Significant Unit (ESU) was ESA-listed as threatened in 1999 (NMFS 2005a). Subsequent harvest rate declines and recovery action implementation have contributed to stabilized and increasing run sizes. Reintroduction programs also appear to be succeeding with natural-origin spawners returning to two streams where summer chum had been extirpated for more than 10 years (Adicks *et al.*, 2007).

Unlike other salmonids that rear in natal freshwater streams and rivers juvenile chum salmon migrate quickly to marine waters after hatching. When the fry first enter saltwater they assemble in small schools and reside close to shore where they can avoid predators and forage on epibenthic prey. Juvenile chum salmon often use small coastal embayments and eelgrass beds as

foraging areas and refuge from predators. As the young fish grow they gradually move to deeper water and generally migrate towards open ocean. Some chum salmon juveniles will remain in the nearshore zone until late in their second year before migrating to the open ocean. These generalized life history characteristics make chum salmon relatively more dependent upon nearshore ecosystems for juvenile and adult growth and survival (Fresh 2006).

d. Puget Sound Chinook Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) range from central California to Kotzebue Sound, Alaska along the coast of North America. Abundance estimates for the Puget Sound ESU east of the Elwha River indicate that most populations are at a small fraction of their historic levels; several populations within the Nooksack, Lake Washington, mid-Hood Canal, Puyallup, and Dungeness basins have returns of fewer than 200 adult fish signifying extinction risk. Only the upper-Skagit stocks have returns of native (non-hatchery) fish in excess of 10,000 adults. A 1998 status review of these populations indicated a decline of 1.1 percent per year; more recent calculations indicate a slower decline (Shared Strategy 2007). Identified threats to Puget Sound Chinook salmon include degradation and loss of estuarine wetlands utilized by juveniles, sedimentation of upper tributary spawning reaches from forest management, and fish passage barriers and altered hydraulic flows from dams that limit access to habitat (Good *et al.*, 2005). The Puget Sound Chinook salmon ESU is ESA-listed as threatened (NMFS 2005a). Critical habitat exists throughout Puget Sound and its tributaries.

Chinook within the range of the study area exhibit a wide range of variability in life history including duration of freshwater residence for juveniles following emergence, variation in age of downstream migration (both within and between watershed-specific stocks), ocean distribution and ocean migratory patterns, and variation in age of spawning migrations. Downstream migration of juveniles and associated relative importance of freshwater or estuarine habitats for rearing can be generalized as stream-type and ocean-type life histories (Healey 1982). Stream-type populations may rear as juveniles in freshwater streams for one to three years prior to migrating downstream to marine waters. Ocean-type populations migrate within their first year relying on estuarine and nearshore marine habitats for juvenile rearing, including foraging and refuge from predation. Among the ocean-type populations of the Skagit River, Beamer and Larsen (2004) found a density-dependent relationship and displacement of fry migrants due to lack of estuarine habitat capacity. Juveniles arriving later in the season were unable to access high quality tidal channel and marsh habitats because earlier migrants occupied these areas. These late arrivals were forced downstream into marine nearshore areas with lower prey resource availability and higher predation rates, decreasing survival rates for this segment of the population. Presumably greater abundance of estuarine habitats would have led to overall increases in juvenile survival, and by extrapolation, adult returns and run size.

The Shared Strategy for Puget Sound facilitated development of a plan for Puget Sound salmon recovery organized by local watershed planning areas. The recovery plan has been adopted by NMFS and focuses on habitat restoration, harvest regulations, and interaction with hatchery fish (Shared Strategy 2007). Responsibility for the oversight of Puget Sound Chinook recovery plan implementation transferred to the Puget Sound Partnership in 2008.

e. Coastal/Puget Sound Bull Trout

Bull trout (*Salvelinus confluentus*) are native char of Washington, Oregon, Idaho, Nevada, Montana, and western Canada. Combinations of factors including habitat degradation, expansion of exotic species, and exploitation have contributed to the decline and fragmentation of bull trout populations. Puget Sound bull trout are ESA-listed as threatened (USFWS 1999). Critical habitat exists throughout much of Puget Sound and its tributaries. The Federal Draft Recovery Plan for Puget Sound Bull Trout focuses primarily on habitat including water quality and temperature (USFWS, 2004).

Eight bull trout core areas have been defined for watersheds along the eastern side of Puget Sound (Chester Morse Lake, Upper Skagit, Lower Skagit, Nooksack, Puyallup, Snohomish/Skykomish, Stilliguamish, and Chilliwack). Six populations on the Olympic Peninsula are limited to the Strait of Juan de Fuca and Hood Canal (Dungeness, Elwha, Hoh, Queets, Quinault, and Skokomish). Each core area has associated populations within it that exhibit varying life history types and spawning areas. Currently, no bull trout populations are known to use tributaries or estuaries on the western side of Puget Sound.

Bull trout are a wide-ranging species with multiple life history forms and a complex population structure reflecting a high degree of local site fidelity (Kanda and Allendorf 2001) and substantial genetic divergence between populations (Dunham and Rieman 1999; Spruell and Maxwell 2002). This diversity makes generalizing bull trout use of nearshore areas difficult. Bull trout have migratory and resident life history strategies. Residents spend their entire life cycle in the tributary streams in which they spawn and rear, whereas migratory forms rear in freshwater and then migrate to either a lake (adfluvial), a river (fluvial), or to saltwater (anadromous) (USFWS 2004). Unlike Pacific salmon anadromous bull trout are year-round residents of the Puget Sound basin. In marine areas sub-adult and adult bull trout commonly forage in shallow nearshore habitat and natal and non-natal estuaries along the shoreline. Primary prey items include surf smelt, sand lance, Pacific herring and juvenile salmonids.

f. Puget Sound Steelhead

Steelhead (*Oncorhynchus mykiss*) range from Kamchatka in Asia, east to Alaska, and south along the Pacific Coast to southern California (Busby *et al.*, 1996). Rapid declines have been observed over the past 10-plus years in Puget Sound steelhead populations with marked decreases observed within the Strait of Juan de Fuca, Bellingham Bay, Hood Canal, and south Puget Sound. Speculated causes of these declines include climate change, hatchery production, harvesting, and increased UV radiation (Hard *et al.*, 2007). Puget Sound steelhead are ESA-listed as threatened (NMFS 2007b). There are currently no recovery plans for Puget Sound steelhead.

Relative to the longer nearshore rearing periods of other juvenile salmonids, juvenile steelhead smolts generally outmigrate from natal streams to offshore areas rapidly. Once in saltwater, they quickly move into deeper water, and the transit time through the Puget Sound to the ocean is brief (15 to 25 days). Their diet while in Puget Sound is largely unknown due to lack of

samples, but they are thought to eat squid and small fish (Goetz, pers. comm. 2012) Few reference sources discuss estuarine use by steelhead adults.

g. Green Sturgeon

Green sturgeon (*Acipenser medirostris*) are broadly distributed from Mexico to Alaska along the coast of North America. After completion of a study of its status (Adams *et al.*, 2002) NMFS determined that the green sturgeon is comprised of two DPSs that qualify as species under the ESA. In 2002 NMFS determined that the Northern distinct population segment (DPS) was not warranted for listing as threatened or endangered (NMFS 2002). The Southern DPS of green sturgeon is ESA-listed as threatened (NMFS 2006a). Threats to the listed entity are primarily attributed to reduction in spawning area to a limited number of rivers including the Sacramento, Rogue, and Klamath; limiting factors are not closely tied to Puget Sound. In Washington, critical habitat was designated for green sturgeon along the outer coast, the Strait of Juan de Fuca, and the southern portions of the San Juan Islands. No critical habitat exists in Puget Sound proper (NMFS 2009a). There is currently no recovery plan for green sturgeon.

h. Southern Resident Killer Whale

Killer whales (*Orcinus orca*) are one of the most widely distributed marine mammals, found in all parts of the world's oceans. They are most abundant in colder waters including Antarctica, the North Atlantic, and Pacific Oceans. Southern Resident killer whales are one of four identified populations of killer whales in the North Pacific and the only known resident population to occur in the U.S. Southern residents are comprised of three pods: J, K, and L pods. The Southern Residents are considered one "stock" under the Marine Mammal Protection Act (MMPA) and one "distinct population segment" (therefore "species") under the ESA. The Southern Resident killer whale population is currently estimated at about 80 whales, a decline from its estimated historical level of about 200 during the late 1800s. Due to its small population size NMFS listed this segment of the population as endangered under the ESA in 2005 (NMFS 2005b) and designated critical habitat in 2006 (NMFS 2006b). A final recovery plan for the Southern Resident killer whale was published on January 24, 2008 (NMFS 2008).

Killer whales dependence on nearshore ecosystems can be tied to the importance of Chinook salmon in their diets. Chinook are a key prey item for resident killer whales (Ford *et al.*, 1998). Researchers in coastal British Columbia observed that 72.2% of the 396 salmon taken by killer whales were Chinook, despite the much higher abundance of the other species (Ford and Ellis 2005). Bioaccumulation of contaminants from prey resources originating from industrial areas has been identified as an on-going threat to killer whale survival (Ross *et al.*, 2000; Ross *et al.*, 2004).

i. Humpback Whale

The humpback whale (*Megaptera novaeangliae*) was globally listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, the precursor to the ESA. In April 2015, NMFS completed a comprehensive status review and proposed revisions to the listing

(NMFS 2015). The currently single population would be divided into 14 distinct population segments (DPS) and listing status revised accordingly. The proposed western North Pacific DPS would be classified as threatened under the ESA. The public comment period has closed and NMFS has not yet issued a final rule. Until a final rule is issued the current status of humpback whale as ESA-listed endangered remains effective.

The humpback whale is at best an infrequent transient of inland Puget Sound waters, more commonly observed along the outer Washington coast (Calambokidis and Steiger 1990). USACE has determined that the PSNERP project will have no effect on humpback whales.

j. Marbled Murrelet

Marbled murrelet (*Brachyramphus marmoratus*) is a small marine diving bird that occurs from southern California to Alaska. Few data are available to interpret trends in population; however, there was an estimated 51% decline in north Puget Sound between 1978 and 2003 (Huff *et al.*, 2006). Recent trends indicate a continued steady decline of marbled murrelets, with a decrease in population of 7.9% from 2000 to 2009 in Puget Sound and the Strait of Juan de Fuca (USFWS 2009). Threats include habitat loss from timber harvest in their terrestrial environment, and harmful algal blooms, declining prey availability (forage fish), and catastrophic events such as oil spills in their marine environment. Due to rapid declines in population and on-going threats to their continued existence marbled murrelet were ESA-listed as threatened in 1992 (USFWS 1992).

Murrelets are common winter residents in northern portions of Puget Sound. Forage habitat is deeper water in entrance channels of rocky shores, estuaries, and protected bays (Angell and Balcomb 1982). Common prey items are forage fish like sand lance, smelt, and herring (USFWS 1997). Critical habitat includes upland forested stands used for nesting but does not include marine water used for foraging.

A Federal Recovery Plan for Marbled Murrelet was completed in 1997. The plan focuses on the protection of habitat in the terrestrial environment and acknowledges the need to do so in the marine environment. In addition it discusses reduction of mortality from the net fisheries, minimizing the occurrence of oil spills, implementing silviculture techniques to accelerate habitat development, and the need for research and monitoring (USFWS 1997).

k. Golden Paintbrush

Golden paintbrush (*Castilleja levisecta*) historically occurred at many sites in Puget Sound, British Columbia, and as far south as the Willamette Valley in Oregon. Its extirpation from the majority of these sites, including all of Oregon, led to its ESA listing as threatened (USFWS 1997). The majority of golden paintbrush current distribution is associated with remnant prairie ecosystems and reintroduction sites. While there are some remaining populations in the San Juan Islands and on Whidbey Island it is limited to upland balds and grasslands and is not prevalent in coastal areas. USACE has determined that the PSNERP project will have no effect on golden paintbrush.

2. State-Listed Species

According to a query of the Washington Department of Fish and Wildlife's Priority Habitat and Species database conducted in December 2015 (Mitchell pers. comm.) the following Washington State sensitive species may occur within the vicinity of the area of projects proposed in the APA/RP:

Table 1: State sensitive species in project area.

Common Name	Occurrence Type	Occurrence Class	State Status	Project Name
Bald eagle	Nest	Breeding	Sensitive	Nooksack River Delta
Great egret	Biotic detection	Regular individual	Monitored	Nooksack River Delta
Harbor seal	Haulout	NA	Monitored	Duckabush River Estuary
Harbor seal	Haulout	NA	Monitored	Nooksack River Delta
Western toad	Biotic detection	NA	Candidate	Duckabush River Estuary
Western toad	Biotic detection	NA	Candidate	North Fork Skagit River Delta
American white pelican	Concentration	Unknown	Endangered	Nooksack River Delta
Bald eagle	Concentration	Unknown	Sensitive	Nooksack River Delta

3. Other Salmonid Resources

According to a query of the Statewide Washington Integrated Distribution database conducted in December 2015 (Mitchell pers. comm.) the following salmonid species and runs may utilize watersheds of the projects proposed in the APA/RP:

Table 2: Salmonid species in project area.

Species/Run	Distribution Type	Use Type	Project Name
Coho	Documented	Presence	Duckabush River Estuary
Coho	Documented	Spawning	Duckabush River Estuary
Dolly Varden/ Bull Trout	Documented	Presence	Duckabush River Estuary
Fall Chinook	Documented	Presence	Duckabush River Estuary
Fall Chinook	Documented	Rearing	Duckabush River Estuary
Fall Chum	Documented	Rearing	Duckabush River Estuary

Pink Odd Year	Documented	Presence	Duckabush River Estuary
Pink Odd Year	Documented	Spawning	Duckabush River Estuary
Rainbow Trout	Documented	Presence	Duckabush River Estuary
Resident Coastal Cutthroat	Documented	Presence	Duckabush River Estuary
Resident Coastal Cutthroat	Presumed	Presence	Duckabush River Estuary
Summer Chum	Documented	Presence	Duckabush River Estuary
Summer Steelhead	Presumed	Presence	Duckabush River Estuary
Winter Steelhead	Documented	Presence	Duckabush River Estuary
Coho	Documented	Presence	Nooksack River Delta
Coho	Documented	Rearing	Nooksack River Delta
Coho	Modeled	Presence	Nooksack River Delta
Coho	Presumed	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Documented	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Documented	Rearing	Nooksack River Delta
Dolly Varden/ Bull Trout	Modeled	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Presumed	Presence	Nooksack River Delta
Fall Chinook	Documented	Presence	Nooksack River Delta
Fall Chinook	Documented	Rearing	Nooksack River Delta
Fall Chinook	Modeled	Presence	Nooksack River Delta
Fall Chinook	Presumed	Presence	Nooksack River Delta
Fall Chum	Documented	Presence	Nooksack River Delta
Fall Chum	Modeled	Presence	Nooksack River Delta
Pink Odd Year	Documented	Presence	Nooksack River Delta
Rainbow Trout	Documented	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Documented	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Modeled	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Presumed	Presence	Nooksack River Delta
Sockeye	Documented	Presence	Nooksack River Delta
Sockeye	Documented	Rearing	Nooksack River Delta
Spring Chinook	Documented	Presence	Nooksack River Delta
Summer Steelhead	Documented	Presence	Nooksack River Delta
Winter Steelhead	Documented	Presence	Nooksack River Delta
Winter Steelhead	Modeled	Presence	Nooksack River Delta
Coho	Documented	Presence	N. Fork Skagit River Delta

Coho	Documented	Rearing	N. Fork Skagit River Delta
Coho	Modeled	Presence	N. Fork Skagit River Delta
Dolly Varden/ Bull Trout	Documented	Rearing	N. Fork Skagit River Delta
Fall Chinook	Documented	Presence	N. Fork Skagit River Delta
Fall Chinook	Documented	Rearing	N. Fork Skagit River Delta
Fall Chinook	Modeled	Presence	N. Fork Skagit River Delta
Fall Chum	Documented	Presence	N. Fork Skagit River Delta
Fall Chum	Modeled	Presence	N. Fork Skagit River Delta
Kokanee	Documented	Presence	N. Fork Skagit River Delta
Pink Odd Year	Documented	Presence	N. Fork Skagit River Delta
Pink Odd Year	Modeled	Presence	N. Fork Skagit River Delta
Rainbow Trout	Documented	Presence	N. Fork Skagit River Delta
Resident Coastal Cutthroat	Documented	Presence	N. Fork Skagit River Delta
Sockeye	Documented	Presence	N. Fork Skagit River Delta
Spring Chinook	Documented	Presence	N. Fork Skagit River Delta
Summer Chinook	Documented	Presence	N. Fork Skagit River Delta
Summer Steelhead	Documented	Presence	N. Fork Skagit River Delta
Winter Steelhead	Documented	Presence	N. Fork Skagit River Delta
Winter Steelhead	Modeled	Presence	N. Fork Skagit River Delta

Many of the salmonid fish species which may occur with the project area are in decline due to loss or degradation of habitat. This includes species in Table 2 that are not listed under the ESA and discussed in Section II.C.1. Between 1992 and 2002 The Salmon and Steelhead Stock Inventory, used to compare trends in salmon stocks within Puget Sound, documented a 33% increase in the number of salmon stocks that were listed as depressed or critical (WDFW 1993 and 2002). While habitat protection and restoration actions are on-going, it is likely that populations of anadromous fish will continue to decline due to alterations in rearing and spawning habitat by armoring, filling, and diking of the shoreline, and upper watershed development. The impacts of climate change will likely exacerbate degraded habitat conditions in nearshore areas and may affect populations of anadromous salmonids. For example an 18- to 32-inch sea-level change in the Skagit Delta may reduce the rearing capacity in marshes for juvenile Chinook salmon by an estimated 211,000 and 530,000 fish respectively (Hood 2005). If regional salmon recovery is successful losses may be slowed and eventually reversed. However other factors could influence population trends of salmonids including harvest, environmental contaminants, oceanic conditions, and other aspects of climate change including increased water temperature and changes in stream flows.

IV. EVALUATION METHODOLOGY

There are no known established models or alternative methodologies that can adequately represent and consider the complexities and dynamics of the physical and biological processes interacting in the study area that affect fish, wildlife, and their habitat. Thus best professional judgment and available science were used to evaluate benefits and impacts to fish and wildlife resources associated with implementation of the proposed PSNERP project. Service staff provided technical assistance to USACE and WDFW throughout the 10-plus years of active work of the PDT. This included representation in both interagency technical (i.e. Nearshore Science Team, Implementation Team) and policy (i.e. Steering Committee) groups convened to advise PSNERP. This General Investigation has produced 24 peer reviewed technical reports that document study methods, analytical results, and ecosystem restoration approach. The Service also reviewed numerous studies conducted in the watershed and the study area by USACE and others investigating and documenting fauna, watershed processes, and sources of Puget Sound nearshore ecosystem degradation.

V. FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

To support analysis of without project conditions for the GI, the PDT commissioned a future risk assessment study. Future population estimates associated with a medium regional growth rate provided by the Washington State Office of Financial Management were used to extrapolate a projection of a regional population growing from nearly 4 million residents today to 9.1 million residents by 2065. This increase in population was used in a land development model to forecast changes in land use (Bolte and Vache 2010). With increasing population driving additional development many portions of the Sound are expected to encounter further degradation of nearshore ecosystem processes well beyond current conditions. This analysis suggests that large portions of southern and central Puget Sound will be fall into a category of highly degraded (Schlenger *et al.*, 2011b). Without restoration, existing and future increases in shoreline stressors will contribute to further declines in nearshore habitat quantity, quality, and connectivity. The expanded footprint of degraded areas, combined with climate change and sea-level change, will further imperil the ecosystems that support diverse biological communities that inhabit or otherwise depend on Puget Sound.

Forecasts of future conditions suggest that without significant ecosystem restoration at-risk species may become further imperiled. Sea-level change is likely to cause substantial loss of surf smelt spawning habitat on beaches with armored shorelines because armoring prevents beach migration inland. (Griggs *et al.*, 1994). Reduction in spawning habitat may further depress stocks of surf smelt and other forage fish that rely on beaches. Anadromous fish species, already in decline due to habitat loss, will likely face increased risk of extirpation in highly impacted watersheds. Sea-level change will reduce availability of delta rearing habitats in locations where dikes, roads, and armoring prevent landward migration. Impacts to forage fish and juvenile salmonids will affect birds and mammals that utilize these prey resources. Statistically significant population declines have already been observed in many nearshore dependent bird species including red-throated loon, numerous grebe species, canvasback, scaup, black scoter, common goldeneye, ruddy duck, Bonaparte's gull, glaucous-winged gull, common murre, and marbled murrelet (Bower 2009).

VI. ALTERNATIVES CONSIDERED

A. Formulation of Alternatives

The October 2014 Draft Feasibility Report and Environmental Impact Statement (FR/EIS) evaluated 18 projects for potential implementation by PSNERP and identified a preferred alternative of constructing 11 of these projects (Table 3, Figure 3) (USACE 2014). During a subsequent feasibility study completion strategy workshop attended by representatives of the Office of the Assistant Secretary of the Army, Corps Headquarters, Northwestern Division, Seattle District, and the non-federal sponsor (WDFW), alternatives were modified and a revised preferred alternative developed. Workshop participants revisited the complete list of 36 projects from which the October 2014 alternatives were derived. During this "vertical team" workshop, the list of projects identified by the GI was organized into five categories. The 36 projects developed by PSNERP were assigned one of five categories for a "tiered" approach to implementation based on their status of completion by other programs, suitability for implementation under existing Corps of Engineers Continuing Authority Programs (CAPs), or eligibility for completion through the GI process. This latter category of GI eligible projects was further divided into those projects for which PSNERP provides a sufficient level of detail for immediate authorization, and those projects for which additional data collection and analysis will be required prior to authorization (Table 4).

The outcome of this workshop is outlined in a memorandum from the U.S. Army Corps of Engineers Director of Civil Works (Headquarters) to the Commander of the Northwest Division (Portland) (USACE 2015). This includes the outcome of the workshop in categorizing restoration projects for implementation under USACE authorities. Most notably, the memo identifies three projects which met the definition of Category 4 (Table 4) and could therefore be advanced by USACE for implementation as an outcome of the GI.

Based on this guidance the subset of 18 potential projects (Figure 3) has been reformulated to derive a new alternative. This new Alternative 4 is the current Agency Preferred Alternative/Recommend Plan for the purposes of the NEPA analysis documented in the FR/EIS (Table 3).

B. Additional Actions of the Tiered Approach

In addition to the three sites now proposed as the APA/RP, nine sites were determined to be potentially eligible for completion through a Corps GI authority. However these projects currently lack sufficient engineering design and other detail sufficient for implementation at this time. Therefore, in addition to the three sites for construction authorization, USACE has identified nine sites to be the subject of additional future studies prior to potential request for authorization:

- Dugualla Bay
- Everett Marshland
- Telegraph Slough

- Chambers Bay
- Big Beef Creek Estuary
- Tahuya River Estuary
- Lilliwaup Estuary Restoration
- Big Quilcene River
- Snohomish Estuary Main Stem

In addition to completion of the three projects included in the APA/RP and potential future authorization of nine projects listed above, USACE and WDFW propose to pursue implementation of up to 12 additional projects outside of the GI process using other programs and authorities, including CAPs. Sites that could be completed through existing authorities include:

Projects that can be implemented under the Water Resources Development Act (WRDA) 2000 §544 Puget Sound and Adjacent Waters authority.

- Spencer Island
- Quilceda Estuary
- Twanoh State Park Beach
- Twin Rivers

Projects that can be implemented under WRDA §206 or §1135 Continuing Authorities Programs.

- Deepwater Slough
- Livingston Bay
- Harper Estuary
- Budd Inlet Beach
- Everett Riverfront Wetlands
- Chuckanut Estuary
- Sequalitchew Creek
- McGlinn Island

Taken together, the three projects proposed for immediate implementation, nines sites identified for additional study and potential future authorization, and 12 sites that can be implemented utilizing existing authorities and programs comprise the tiered approach to nearshore ecosystem restoration now envisioned by USACE and WDFW.

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Table 3: Revised Alternatives and Associated Project Sites.

Alternative ID - Name	Project Site Names
Alternative 1 - No Action	
Alternative 2 - 11 Sites	
	Deepwater Slough
	Everett Marshland
	Milltown Island
	Nooksack River Delta
	North Fork Skagit River Delta
	Spencer Island
	Telegraph Slough
	Deer Harbor Estuary
	Dugualla Bay
	Livingston Bay
	Beaconsfield Feeder Bluff
Alternative 3 - 18 sites	
	Deepwater Slough
	Duckabush River Estuary
	Everett Marshland
	Milltown Island
	Nooksack River Delta
	North Fork Skagit River Delta
	Spencer Island
	Telegraph Slough
	Deer Harbor Estuary
	Harper Estuary
	Snow Creek and Salmon Creek Estuary
	Tahuya River Estuary
	Big Beef Creek Estuary
	Dugualla Bay
	Livingston Bay
	Point Whitney Lagoon
	Beaconsfield Feeder Bluff
	WDNR Budd Inlet Beach
Alternative 4 - 3 sites (preferred alternative)	
	North Fork Skagit
	Nooksack River Delta
	Duckabush River Estuary

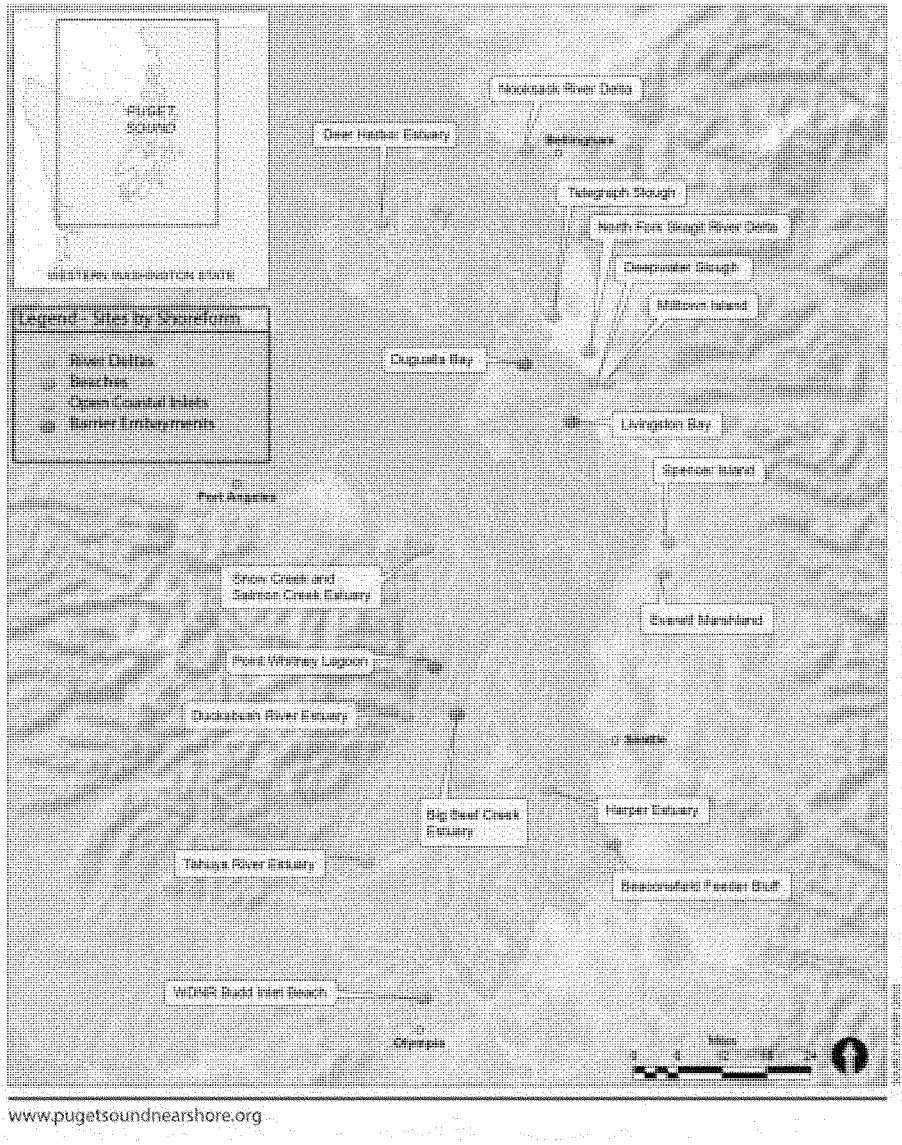

Figure 3: PSNERP Potential Project Sites

Table 4: Categorization of 36 PSNERP Projects by Tier.

Tier	Category	Project Site Names
1	***Projects in which other agencies are moving forward or have implemented restoration***	
		Milltown Island
		Point Whitney Lagoon
		Beaconsfield Feeder Bluff
		Kilisut Harbor/Oak Bay Reconnection
		Deschutes River Estuary
		Hamma Hamma Estuary
		Snow Creek and Salmon Creek Estuary
		Johns Creek Estuary
		Deer Harbor
		Mission Creek
		Smith Island
		Washington Harbor
2	***Projects that can be implemented under WRDA §544 Puget Sound and Adjacent Waters***	
		Spencer Island
		Quilceda Estuary
		Twanoh State Park Beach
		Twin Rivers
3	***Projects that can be implemented under WRDA §206 or §1135 CAPs***	
		Deepwater Slough
		Livingston Bay
		Harper Estuary
		Budd Inlet Beach
		Everett Riverfront Wetlands
		Chuckanut Estuary
		Sequalitchew Creek
		McGlinn Island
4	***Projects that fall within the GI program and have the level of detail to move forward***	
		North Fork Skagit
		Nooksack River Delta
		Duckabush River Estuary
5	***Projects that fall within the GI program but require additional analysis***	
		Dugualla Bay
		Everett Marshland
		Telegraph Slough
		Chambers Bay
		Big Beef Creek Estuary
		Tahuya River Estuary
		Lilliwaup Estuary
		Big Quilcene River
		Snohomish Estuary Main Stem

C. Agency Preferred Alternative / Recommended Plan

The revised APA/RP that USACE and WDFW now propose to advance for PSNERP includes three projects that have sufficient level of analysis to move forward for implementation at this time. These three sites are the focus and outcome of the NEPA process, and represent the primary scope of analysis for the Service's FWCA §2(b) Report:

- North Fork Skagit
- Nooksack River Delta
- Duckabush River Estuary

1. North Fork Skagit River Delta

The North Fork Skagit River empties into Skagit Bay south (downstream) of La Conner, Washington. The proposed action is located between the former Dry Slough inlet and the western levee system's end near Rawlins Road. Extensive diking of the North Fork caused substantial loss of tidal wetlands and associated tidal channels. River levees reduced the floodplain area and constrained the river channel. In the last century the Skagit Basin has lost approximately 80 percent of historic estuarine delta habitat, including a loss of 35 percent of estuarine mixing habitat, 98 percent of low salinity transitional habitat, and 89 percent of its freshwater tidal habitat (Simenstad *et al.*, 2011).

The Skagit River watershed is critically important to all five species of Pacific salmon as well as steelhead and sea-run cutthroat. This importance is due in large part to the productivity of large wilderness areas in the upper watershed upstream from the diked and developed floodplain (SWC 2002). The extensive remnant aquatic habitat in the delta is also an important contributing factor to salmonid productivity and significant loss of tidal wetlands is an established limiting factor for Chinook recovery (SWC 2005). The Skagit watershed supports 30 percent of all anadromous fish in Puget Sound and the largest populations of pink and chum in the contiguous United States (North Cascades Institute 2002, Smith no date). The Skagit River and its tributaries also host the largest populations of ESA-listed bull trout, steelhead, and wild Chinook in the Puget Sound Basin (USFWS 2004, Smith no date).

Declining salmon runs in the Skagit and elsewhere contribute to a cascading series of ecosystem impacts. Fewer returns of naturally spawning fish leads to declining marine nutrient input to riverine ecosystems as well as less food availability for bald eagles, bears, and other species that scavenge carcasses. Numerous species of fish, birds, and mammals – including people – rely upon on abundance and high nutritional value of salmon. Declines of Chinook salmon in marine environments of Puget Sound have been identified as a limiting factor for the ESA-listed southern resident killer whales. Additionally, the depressed levels of salmon populations has all but eliminated the once great commercial fishing industry of western Washington, severely reduced sport fishing, and significantly impacted the Native American tribes whose cultures center on salmon returns (USACE 2016).

The Skagit River Delta area is also a critical waterfowl wintering area due to the mild climate and available habitats including marshes, intertidal flats, and adjacent agricultural fields. It is an important stopping point for migratory birds along the Pacific Flyway including trumpeter swans

and Wrangell Island snow geese. At least 180 species of birds have been documented in the project area including raptors, waterfowl, shorebirds, game birds, and songbirds (WDFW 2006). These birds use the Skagit Basin as over-wintering areas or as permanent residents. Wading birds, such as great blue heron, utilize the estuary areas year round. Shorebirds use flooded agricultural fields and estuaries primarily for feeding station during their long migration and as over-wintering habitat. Dunlin and black bellied plover winter in the Skagit delta. Although a large number and variety of birds use the area this broad delta could be substantially more productive in its restored condition with native plants and greater areas of distributary channels in the nearshore zone to support significantly greater populations of birds.

a. Key Design Elements

The restoration proposal lowers 13,000 linear feet of levee along the North Fork Skagit River south bank. Work will remove several structures and construct a levee along Rawlins Road as well as lower 3,140 feet of levee along the north bank. Existing topography provides flood risk management without a levee on the river's north side. Breaches in the lowered levees and excavated channels allow for water to access the newly restored floodplain restoring tidal hydrology to approximately 250 acres of historic tidal marsh habitat. Replanting lowered levees will restore a natural riparian corridor along the river (Figure 4). Total project costs are estimated at $102 million.

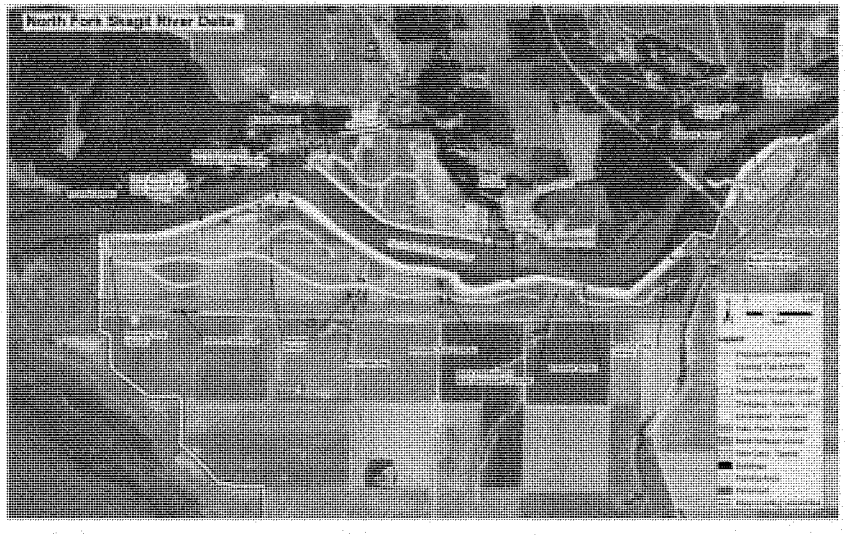

Figure 4: Key restoration design elements for North Fork Skagit River delta site.

2. Nooksack River Delta

The Nooksack is one of the largest contributing watersheds in Puget Sound and supports numerous salmonid stocks with relatively high abundance. The Nooksack River system supports nine species of salmonids represented by more than 20 distinct stocks that are separated by their run timing and spawning location. Three of these species are listed under the ESA: Puget Sound Chinook, Puget Sound steelhead, and Coastal/Puget Sound bull trout. The Nooksack River is one of five geographic areas considered essential for recovery of the Puget Sound Chinook ESU. Other anadromous salmonid species found in the Nooksack River include riverine sockeye, coho, even-year and odd-year pink, and chum salmon; summer and winter steelhead; and coastal cutthroat trout. Runs of all of these species have declined significantly from historic levels. In addition to a critical importance for fishery resources the Nooksack River delta provides important habitat for migratory shorebirds of the Pacific Flyway, waterfowl, trumpeter swans, Canada geese, and the Wrangell Island snow geese.

The Nooksack River delta is located on the Lummi Nation lands north of Bellingham, Washington. It includes nearly all of the Nooksack and Lummi River estuaries below Ferndale, Washington. The Nooksack and Lummi River flow paths have been modified since the mid-19th century beginning with active removal of large wood, draining, diking and levee construction. Today substantial surface water diversions, groundwater withdrawals, and drainage activities within the Nooksack River watershed impact the magnitude, timing and duration of delta surface water flows. The Nooksack floodplain has undergone a substantial loss of tidal freshwater and estuarine wetlands from an estimated 8,785 acres in 1888 to 3,211 acres remaining today, representing a 64% loss. This includes a 71% loss of vegetated tidal wetlands. More than half of the remaining acreage is disconnected from its natural hydrology by dikes, roads, and tidegates. The proposed restoration modifies levees, roads, and other hydrological barriers, restoring delta riverine and tidal flow, as well as sediment transport and delivery processes.

a. Key Design Elements

The restoration actions include partial levee removal along both Nooksack River banks and levee construction on North Red River Road. Approximately 12,000 linear feet of levees would be breached or removed, restoring 1,800 acres of tidal freshwater wetlands. Existing levels of flood protection for buildings, roads, and other infrastructure will be maintained by construction of new setback levees, often concurrent with existing arterial roads. Log jams installed on the Nooksack River would restore more natural channel morphology and enhance instream habitat availability. The Lummi River channel will be dredged and graded to reconnect it to Nooksack River flows. A water control structure at the historic divergence of Lummi and Nooksack River would replace the current dike which prevents freshwater from entering the Lummi River facilitating transfer of water and sediment to the restored channel. Old agricultural ditches will be filled and tidal channels recreated. Several roads on filled causeways would be replaced with widespan bridges to allow more tidal flows across the delta (Figure 5). This combination of numerous significant project features implemented at a large scale leads to a total project cost estimate of $260 million.

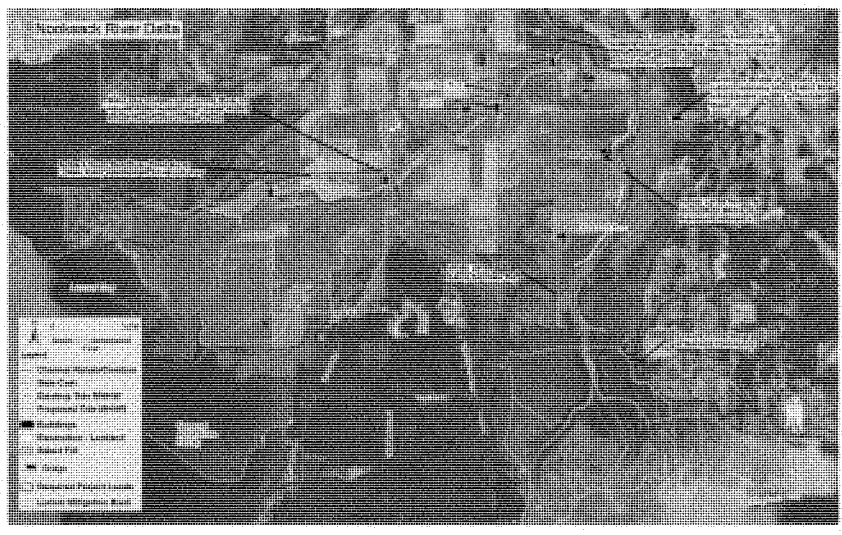

Figure 5: Key design elements for the Nooksack River delta site.

3. Duckabush River Estuary

The Duckabush River is one of several major river systems that drain the east slope of the Olympic Mountains to Hood Canal. The broad river delta fans out into Hood Canal on the south side of Black Point Peninsula. The Highway 101 causeway crosses the delta spanning the main channel and a historic distributary channel via bridges with box culverts. Levees along the main channel upstream of the causeway prevent river flows into historic distributary channels. This causeway limits tidal exchange resulting in the aggradation of tidal channel networks and inhibition of channel migration. These hydrologic constrictions along with fill within the estuary have led to decline in mudflats and salt marsh.

The Duckabush River supports four ESA-listed species of salmonids: Hood Canal summer chum, Puget Sound steelhead, Coastal/Puget Sound bull trout, and Puget Sound Chinook salmon. The wild Chinook run is nearly extirpated from this river. The Duckabush Estuary also supports important wildlife resources including trumpeter swans, bald eagles, and regionally significant concentrations of wintering waterfowl. Harbor seals haul out in this location throughout the year and pupping occurs in the winter. The extensive mud and gravel flats are productive shellfish beds. Salt marshes and eelgrass beds characterize the upper and lower intertidal and subtidal areas, respectively. Herring use this eelgrass for spawning.

a. Key Design Elements

Proposed restoration actions would restore natural hydrology to approximately 38 acres of the Duckabush River delta. Key features of the project include replacement of the Highway 101 fill causeway with a bridge of sufficient span to allow unconstrained riverine and tidal hydrology. This is the primary measure for this site as the Highway 101 causeway and two bridges structures are the key impediment to ecosystem process restoration at the site. Fill associated with Shorewood Road and other areas that impact floodplain wetlands would be removed and regraded. Filled distributary channels and sloughs would be excavated and large wood placed to reinitiate channel forming processes (Figure 6). Reinitiating natural water and sediment processes would also benefit downstream habitats allowing tidal flats and salt marsh habitats to accrete sediment and remain resilient in response to changing sea levels. Replacement of over 1,200 linear feet of a major highway river crossing contributes significantly to the $63 million estimated total project cost.

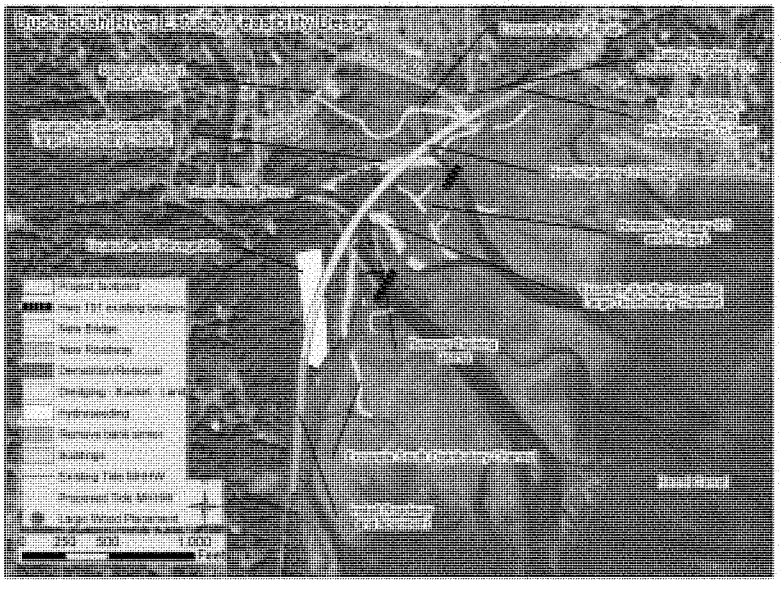

Figure 6: Key design elements for the Duckabush River Estuary site.

D. Other Alternatives

The other two action alternatives (Alternatives 2 and 3; see Table 3) include a greater number of projects for implementation under the PSNERP program. These alternatives were the subject of the 2014 Draft Feasibility Report / Environment Impact Statement. Alternative 2 proposed the implementation of 11 restoration sites. The 2014 DFR/EIS identified this as the Preferred Alternative / Tentatively Selected Plan. Alternative 3 involved a larger program of 18

restoration sites (Figure 3). As discussed above in Section VI.A, during review of these alternatives by Corps Headquarters, Alternative 4 was formulated with the Project Delivery Team (Seattle District and WDFW) and emerged as the Agency Preferred Alternative / Recommended Plan (APA/RP).

VII. PROJECT IMPACTS

A. Preferred Alternative / Recommended Plan

A full description and evaluation of project impacts is not possible since project designs for sites included in the APA/RP (and other action alternatives) are only at the conceptual stage of development. If authorized for implementation, future phases of the project would finalize project features and complete detailed engineering design. This will include additional discussions with effected landowners which may impact the footprint and scope of restoration actions.

In general there will be short-term negative impacts from construction of each action including diminished water quality (turbidity and suspended sediment), noise disturbance from construction machinery, airborne particulates from soil disturbance, and vegetation removal and disturbance associated with construction of temporary equipment access routes and conducting activities at each work site. These construction-related effects are common to many restoration activities and standard conservation measures and best management practices are generally followed to minimize the frequency, intensity, and duration of these impacts. For example, in designing and implementing Service-funded restoration projects, partners adhere to standard best management practices (BMPs and conservation measures (CMs) outlined in a programmatic biological assessment/biological opinion (USFWS 2015). All of the PSNERP proposed restoration actions have analogs in this programmatic consultation document and it is anticipated that USACE BMPs/CMs would be similar to those outlined in this and other restoration guidance.

The goal of PSNERP is to restore ecosystem process and habitat to provide long-term benefits to fish and wildlife species from implementing the actions identified in the APA/RP. In all cases it is reasonable to expect that benefits will outweigh negative impacts. Potential beneficial and negative impacts of each proposed action are discussed below. A more thorough evaluation of effects of implementing the APA/RP will be possible as the project advances into the design stage.

1. North Fork Skagit River Delta

a. Ecosystem Restoration Benefits

Project benefits extend across an estimated 256 acres where daily tidal and seasonal/episodic flood flows would be restored (Figure 7). Removal of barriers to tidal and riverine hydrology reestablishes important habitat-forming ecosystem processes including sediment transport, freshwater input, tidal exchange, channel migration, marsh accretion, overbank deposition, and natural levee formation. Ecosystem benefits include the restoration of highly productive tidal

wetland habitats that support diverse fish and wildlife resources and provide connectivity between terrestrial and nearshore ecosystems. River delta ecosystems provide valuable rearing habitat for numerous species of juvenile salmonids, increasing survival and supporting recovery of Puget Sound populations, including threatened Chinook salmon and bull trout.

This project will also contribute to increases in shorebird foraging and resting habitats associated with tidal flats benefitting dunlin, great blue heron, and other wading/probing birds. Restoration of sediment input will promote marsh accretion downstream from the project site improving resilience of the estuary to effects of sea level change. Water quality will be improved by increasing floodplain retention time and flow through vegetated wetlands.

The significance of this project is underscored by its identification in the Skagit River watershed chapter of the Puget Sound Chinook Salmon Recovery Plan (Shared Strategy 2007). To date, most Skagit estuary restoration projects have been implemented along the South Fork Skagit River. This project would provide a significant increase in estuarine habitat on the lower North Fork Skagit River where developed and agricultural lands behind constructed flood control levees limit available habitat and restoration opportunities.

The separately authorized and implemented Skagit River General Investigation Feasibility Study is recommending flood risk management actions well upstream of the North Fork Skagit River project site. Ecosystem restoration actions proposed as part of the PSNERP recommended plan are independent from the Skagit flood risk management recommendations and are described as complementary to those separately proposed actions (USACE 2014).

b. Potential Adverse Impacts

Common to other sites where extensive excavation is proposed to remove or setback levees and restore filled tidal channels, this project would have temporary adverse impacts on aquatic habitats and organisms. Negative impacts include increased turbidity from excavation and dredging. Consistent with permit conditions and conservation measures construction would be limited to designated annual work windows when fish are less likely to be present and during low tides. Depending on specific construction activities at this site it may be necessary to install cofferdams or other water isolation structures to separate in-water construction activities from areas where fish or other wildlife sensitive to turbidity are present. Programmatic consultation documents for restoration projects identify these and other best management practices (BMP's) to ensure minimization of short term impacts. It is reasonable to anticipate that site specific BMP's will be developed following resolution of engineering design details, construction methods, sequencing of actions and project schedule.

There is a report indicating that a historic landfill or dump may exist within the project footprint. However there are no known active cleanup sites within the project footprint and no site records listed on the WDOE clean-up site database. Service (USFWS 2011) preliminary contaminant screening did not confirm this report. Additional site assessments are planned to determine if unresolvable contaminant issues exist within the project area. If contaminants are found to be present, those areas would be excluded from USACE restoration activities.

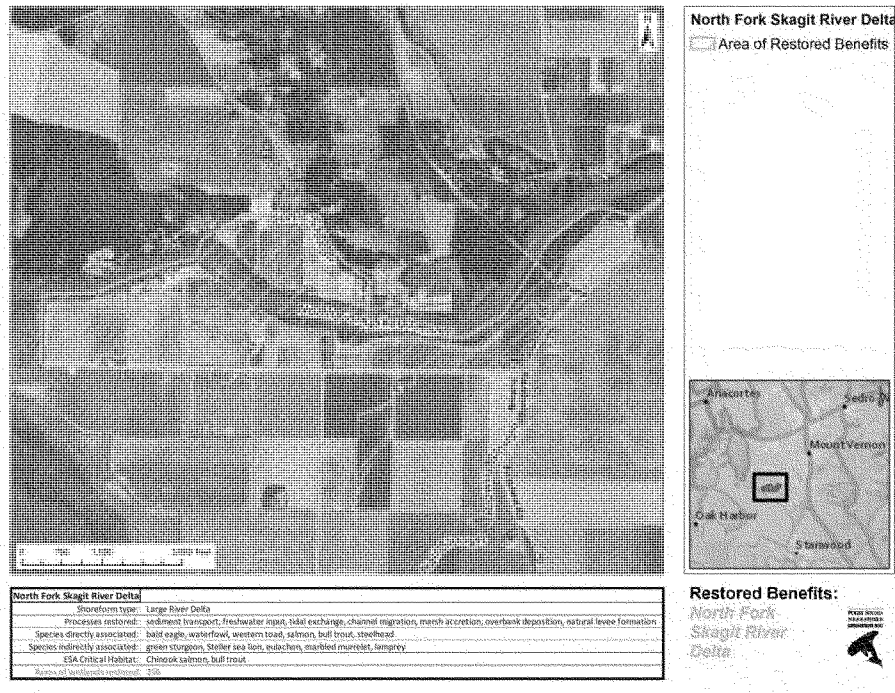

Figure 7: Area of Restored Benefits at North Fork Skagit River Delta site (from USACE 2014).

2. Nooksack River Delta

a. Ecosystem Restoration Benefits

As described above in VI.B.2 the Nooksack River delta project includes numerous actions across a large portion of the lower 2 miles of the Nooksack and Lummi Rivers. Actions planned to increase flood plain area and reconnect tidal and riverine flows would restore some 1,807 acres of scarce tidal freshwater wetlands. Removal of levees and other anthropogenic stressors will reinitiate sediment transport, freshwater input, tidal exchange, channel migration, marsh accretion, and longshore sediment transport processes. Resulting habitat benefits Chinook salmon and bull trout as well as peregrine falcon, bald eagle, shorebirds, waterfowl, invertebrates, forage fish, and eelgrass. Proposed restoration complements, but does not depend on, the proposed Lummi Nation Wetland and Habitat Bank project downstream and adjacent to this site (Lummi Nation 2008).

This project will restore a very large area of the river delta that provides valuable nursery habitat for juvenile salmonids, increasing survival and supporting Puget Sound population recovery.

Re-established intertidal and shallow subtidal areas would facilitate kelp and eelgrass growth, increasing nearshore productivity for fish, birds and other marine species. This project would restore important landscape features, including connectivity between nearshore and adjacent uplands, and shoreline area, length, and complexity. Benefits include improved resiliency of the shoreline to respond to rising sea levels and increased frequency of storm and flood events linked to climate change.

Significant in scale as a stand-alone action, this project also builds on the Lummi Nation's existing and planned mitigation bank projects that similarly restore delta ecosystem processes and habitats. These projects are also central to Whatcom County's comprehensive approach to managing flooding and restoring estuary habitat in the lower Nooksack River. Restoration actions are aligned with the Puget Sound Chinook Salmon Recovery Plan. Implementation will provide 25 percent of Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in this single project (PSP 2014).

b. Potential Adverse Impacts

Extensive levee setback and removal actions are proposed for this site. Similar to effects described for North Fork Skagit short-term impacts from increased turbidity can be expected from excavation work that would degrade water quality. This project also involves the replacement of bridges on the Lummi River and Tennant Creek (tributary to Nooksack). Bridge construction often involves various construction methods including use of tugboats, drilling, rock placement, and pile driving. Sound levels associated with these activities would temporarily increase during construction with some noise-generating activity potentially exceeding thresholds that are harmful to fish and wildlife. Estimates of sound levels should be calculated once project implementation details have been established and compared to data available on aquatic species' hearing and the regulated sound threshold under the ESA and the MMPA. Each method of construction that produces harmful underwater noise should be mitigated through physical means such as bubble curtains and sound dampening mats or through conservation measures including wildlife monitoring. Preliminary site construction plans avoid pile driving, the most deleterious of potential noise generating actions. Bridge supports are proposed as drilled shafts and poured concrete piers instead of compression driven steel piles.

The Lummi Nation has expressed concerns about the potential for reestablishing Lummi River flows to adversely affect tribal shellfish operations. Tribal concerns involve the potential for increased delivery of pollutants from the Nooksack River to Lummi Bay. Restoration of Lummi River flows will require assessment of upstream water quality and modeling of downstream impacts to receiving waters. USACE acknowledges the need for analysis of effects to water quality during the design phase to avoid impacting shellfish beds.

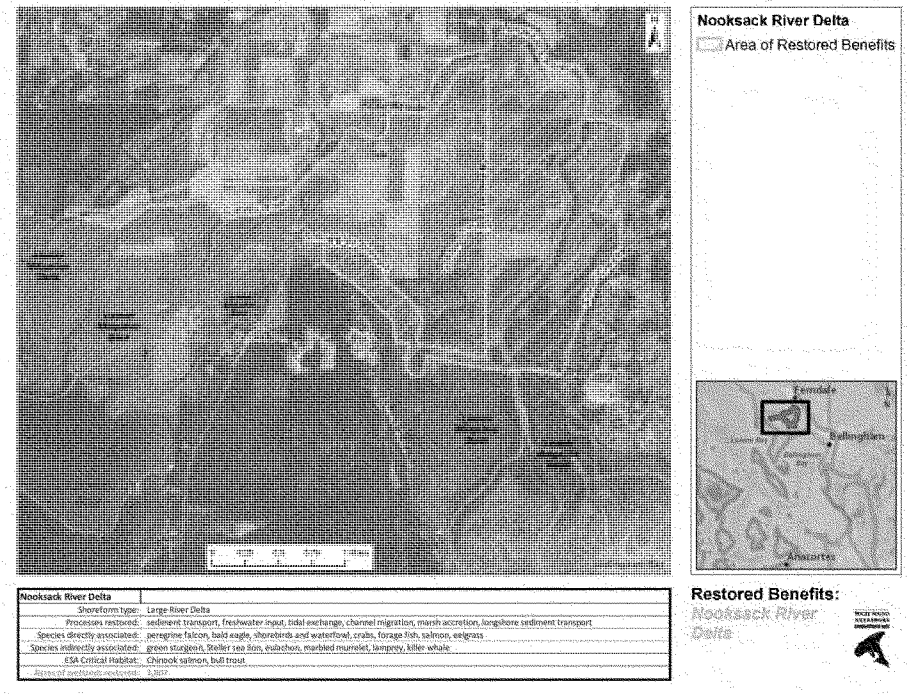

Figure 8: Area of Restored Benefits at Nooksack River Delta site (from USACE 2014).

3. Duckabush River Estuary

a. Ecosystem Restoration Benefits

Restoration of this site provides benefits to ESA listed Chinook, Hood Canal summer chum, steelhead, and bull trout. The project provides direct benefits to harbor seals, bald eagles, waterfowl, shellfish, and eelgrass habitat at the edge of the site. Duckabush estuary restoration provides an opportunity to reconnect floodplain and intertidal wetlands, improving tidal exchange, sediment transport, and estuary development. Realignment of roads and bridges will restore tidal inundation and hydrology. Reconnection of distributary channels will promote greater diversity and resiliency of delta wetland habitats.

In addition to these habitat benefits the project may also improve intertidal and shallow subtidal areas that support important recreational and tribal shellfish resources. Oysters, clams, and mussels are harvested on lands managed by Washington Department of Fish and Wildlife for this purpose. Channelization of the Duckabush River and the hydraulic constraints of the current bridge-opening direct sediment to a relatively small portion of the delta leaving large areas of

tidal flats disconnected from sediment supplies and vulnerable to loss from erosion and sea level change.

b. Potential Adverse Impacts

Bridge replacement is a major construction element of this project. Short-term impacts to turbidity can be expected following fill removal and channel reconstruction. In-water work is required for bridge replacement. However, pile driving is not proposed. Existing piles will be removed and test holes will used to assess substrate stability. Neither of these activities creates noise levels commensurate with pile driving. New bridge supports will be drilled and cast in place concrete piers to minimize noise impacts to aquatic species.

While general concerns discussed for the previous projects apply at this site as well, at this phase of design development, no site-specific potential adverse impacts to the biological environment have been identified.

The Duckabush River Bridge is listed on the National Register of Historic Places. Removal and replacement of this historic resource will require compliance with Section 106 of the National Historic Preservation Act (NHPA) including mitigation of impacts. USACE indicates that they are currently working on a Programmatic Agreement with the Washington State Historic Preservation Office, the Advisory Council of Historic Preservation, interested Tribes, and members of the public to address NHPA compliance for this site and other potentially affected cultural and historic resources.

B. Other Plans

The No Action Alternative (Alternative 1) would allow causes and consequences of nearshore ecosystem degradation to persist and worsen. Section V provides a discussion of the likely implications to fish and wildlife resources in the study area if proposed restoration actions are not implemented.

Other action alternatives anticipate implementation of substantially more restoration than that proposed by the agency preferred alternative / recommended plan. Alternative 2 would advance 11 sites for construction and was the initial APA/RP. Alternative 3 assessed environmental outcomes of restoration at 18 sites across Puget Sound including the 3 proposed under the current APA/RP.

Alternative 2 would restore 5,348 acres of nearshore habitat. This compares to 5,517 for Alternative 3 (1,807 restored for Alternative 4). These alternatives would more completely address project objectives by including one or more beach restoration sites involving armor removal. These alternatives also include sites where tidal hydrology is restored to coastal embayments, "pocket estuary" features not associated with one of the 16 major river deltas in the study area. Alternative 4 does not include beach or embayment sites and focuses largely on river delta restoration. The 11 sites that comprise Alternative 2 have a total cost of approximately $1,063,899,000; the Alternative 3 sites have a total cost of approximately $1,243,408,000. For comparison, total costs of the APA/RP (Alternative 4) are approximately $425,362,000.

VIII. EVALUATION OF ALTERNATIVES

Soundwide systematic analysis completed by the PSNERP PDT led to definition of six problem statements based on this scientific analysis. These problem statements provide a clear rationale for addressing the underlying causes of widespread nearshore ecosystem degradation and habitat loss. Large river deltas, smaller coastal embayments, and the bluff/beach systems that dominate the Puget Sound shorescape have all been widely impacted and are greatly diminished in quantity, quality, and connectivity relative to conditions in c.a. 1850. Numerous fish and wildlife resources rely upon these productive ecosystems that occupy the terrestrial/marine ecotone. Emblematic of the relationship between nearshore habitat loss and degradation are Pacific salmon species. While overfishing and upper watershed habitat impacts have contributed to the systematic decline in salmon production, estuarine wetland habitat loss which averages 55% in Puget Sound is a significant limiting factor for species recovery. Declines in populations of marine birds and other species show similar correlations between nearshore habitat loss and observed population declines. These observations support the conclusion of a compelling need for significant, large-scale nearshore ecosystem restoration. The study area is clearly in need of restoration to improve habitat conditions for listed and non-listed fish and other aquatic species, and for general aquatic ecosystem health.

The no action alternative (Alternative 1) would allow causes and consequences of nearshore ecosystem degradation to persist and perhaps worsen. Failure to implement projects following the substantial investment USACE, WDFW, the Service, and other partners have made towards the success of PSNEP would represent a significant missed opportunity. Western Washington tribes have asserted that habitat restoration efforts are not keeping pace with on-going habitat loss in Puget Sound. Nearshore habitat loss is impeding salmon recovery efforts to the detriment of tribes who depend on treaty reserved fishing rights for economic and cultural sustenance (NWIFC 2011). Federal agencies, including USACE, have an obligation to contribute to Puget Sound recovery; implementation of projects through the GI and other authorities provides an opportunity to do so.

Providing substantially less benefit than other action alternatives, Alternative 4 is the agency preferred alternative/recommended plan and would significantly contribute to Puget Sound recovery. Nooksack, Skagit, and Hood Canal are priority areas for recovery and Alternative 4 proposes important advances in these regions by implementing over 1,800 acres of nearshore restoration focused in river deltas. These projects will provide numerous ecosystem benefits and provide important habitat for fish and wildlife resources discussed above. Adverse environmental effects are minor in scale and duration compared to ecosystem benefits. Most adverse effects can be significantly minimized by implementing standard best management practices including timing construction activities for periods when fish and wildlife are less likely to be present.

Alternative 2, involving implementation of 11 restoration projects throughout the study area, would provide substantially greater ecosystem benefits than the APA/PR. Nearly 3 times as many acres of intertidal habitat would be restored, at a commensurate increase in project costs. While this alternative was originally identified as the Tentatively Selected Plan in the Draft FR/EIS, USACE is now advancing a tiered approach to the numerous projects evaluated by the GI and the request for immediate authorization of 3 sites represented in Alternative 4.

Alternative 3, even larger in scope and spatial scale and would advance 18 projects for construction. This alternative would accelerate Puget Sound recovery efforts delivering improvements in nearshore ecosystem conditions throughout the study area. The Service strongly endorses a U.S. Army Corps of Engineers ecosystem restoration authority that would enable this comprehensive alternative. However this alternative did not meet USACE tests of cost effectiveness and was not carried forward due to significant increases in cost for the larger suite of restoration sites.

While not a formal alternative assessed through the USACE NEPA analysis, full implementation of the tiered approach would likely exceed the scope of ecosystem restoration of alternatives evaluated with as many as 24 projects diverse in size and features constructed throughout the entirety of the Puget Sound basin.

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IX. RECOMMENDATIONS FOR FISH AND WILDLIFE CONSERVATION

The Service supports the APA/RP and is providing the following list recommendations to minimize potentially adverse effects and maximize benefits to fish and wildlife resources associated with the proposed actions. Recommendations are divided into two tiers. Tier 1 recommendations are considered essential for minimizing potential negative impacts of the actions and ensuring that intended benefits are realized. Tier 2 recommendations are those that will enhance overall restoration effectiveness in the study area and provide additional benefits beyond those currently represented in the APA/RP.

A. Tier 1 Recommendations: Ensuring APA/RP Effectiveness

1. The Service recommends that USACE adhere to best management practices and conservation measures applicable to construction activities required to implement restoration projects. To achieve the maximum ecosystem benefit from this restoration program USACE should seek to avoid the need for variances and exceptions from practices that avoid or minimize adverse impacts to fish and wildlife resources.

2. For projects requiring replacement of highway and road bridges the Service recommends that USACE implement conceptual designs that avoid pile driving. Current plans specify that new bridge supports will be drilled and cast in place concrete piers to avoid noise impacts to aquatic species.

3. The Service recommends that riparian buffers installed by USACE restoration authorities and programs be consistent with NMFS guidelines for protection of salmon habitat quality. Projects that invest public resources in ecosystem restoration should conform to the highest standards of environmental protection.

4. The Service understands that USACE and WDFW have a significant amount of work remaining to finalize project designs and construction plans. This will include negotiations with landowners and other coordination to establish final project boundaries and the area of restored ecosystem benefits. The Service recommends that USACE and their partners exercise creativity and flexibility in working with landowners and other stakeholders in seeking to establish the maximum amount of ecosystem benefits from restoration projects.

5. The Service suggests that USACE continue to coordinate closely with tribal governments and entities with interest in these projects. In addition to compliance with requirements for formal government-to-government coordination, we strongly advise continued informal coordination with tribal government agency staff and tribal leaders. Success of these projects will be greatly facilitated by integrating collaboration with western Washington tribes throughout the process of project design and implementation.

6. The Service has provided technical assistance to PSNERP throughout the entire GI study process. We request that USACE continue to engage with the Service in the future,

seeking technical assistance to ensure that benefits to fish and wildlife resource are maximized and short-term adverse effects are minimized.

B. Tier 2 Recommendations: Generating Additional Benefits

1. Per the June 2015 guidance memo from of Office of the Assistant Secretary of the Army for Civil Works, USACE and WDFW have developed a tiered implementation approach for all 36 sites identified and evaluated by the General Investigation study. These sites were deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and programs. This Coordination Act Report has focused on the recommended plan and alternatives evaluated in the draft FR/EIS which does not include substantial reference to other sites and implementation pathways. Nonetheless, in addition to the three sites proposed by USACE in their APA/RP, there is significant work to be done outside of an envisioned Nearshore Restoration authority for PSNERP. The Service strongly recommends that USACE adhere to the approach outlined in the guidance memo. This includes aggressive pursuit of opportunities to apply Corps of Engineers' Continuing Authority Program resources (e.g. §1135, §206, §544) to implement those projects deemed more appropriate for CAP implementation than via the PSNERP program (Categories 2 and 3, Table 4).

2. Similar to recommendation B(1) above, the Service recommends that USACE seek a local sponsor to support the required General Investigation(s) for the nine sites identified as falling within the GI program but require additional data collection and/or analysis that would be studied under future feasibility reports (Category 5, Table 4). These nine sites that require additional study prior to eligibility for authorization would more completely realize the potential provided by the extensive analysis of the PSNERP GI and greatly complement the three sites that are the focus of the current APA/RP.

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X. SUMMARY AND THE SERVICE POSITION

The U.S. Fish and Wildlife Service supports the tiered approach for implementation agreed upon by USACE and WDFW for projects identified to address the ecosystem restoration needs documented by the analysis completed under the authority of the Puget Sound Nearshore Ecosystem Restoration General Investigation Study. We specifically endorse:

1. Immediate enactment of the agency preferred alternative/recommended plan. USACE and WDFW should continue engineering design and other tasks required to implement the three projects recommended for implementation by the General Investigation study. Completion of the Nooksack River, North Fork Skagit River, and Duckabush River projects will provide substantial positive benefits to Puget Sound recovery including important benefits for fish and wildlife resources.

2. Aggressive pursuit of opportunities to apply other USACE authorities to implement 12 projects identified by the tiered approach as appropriate for Puget Sound and Adjacent Waters (§544) or Continuing Authority Program (§1135, §206) execution. These projects are within reach of existing authorities and resources and should be implemented as expeditiously as possible.

3. Simultaneous work to develop local sponsorship and USACE vertical team support for additional GI studies to complete additional data collection and analysis required to advance nine projects determined suitable for GI implementation but lacking sufficient information for immediate authorization.

The Service finds substantial value in action alternatives evaluated by the FR/EIS that would have delivered significantly greater ecosystem benefit than the final proposal. However the Service understands that the tiered approach which includes implementation of restoration projects beyond the scope of the APA/RP may provide similar, or perhaps greater, ecosystem benefits than any of the formal NEPA alternatives considered. The path forward agreed upon by USACE Headquarters, USACE Seattle District, and WDFW delivers a desirable outcome in the delivery of authorization for constructing three significant restoration projects, resulting in over 1,800 acres of tidal wetlands. These projects, especially when complemented by other actions identified in the tiered implementation approach, will substantially improve Puget Sound nearshore ecosystem conditions, addressing degradation identified by the GI study. Nearshore restoration at this scale has the potential to contribute substantially to regional Puget Sound recovery efforts and is consistent with the obligations to uphold treaty reserved rights of western Washington tribes. These projects represent a significant contribution to the urgent need to recover Puget Sound ecosystems providing habitat for fish, wildlife, and plants to the continuing benefit of the American people.

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FINAL
Fish and Wildlife Coordination Act
Section 2(b) Report

Puget Sound Nearshore Ecosystem Restoration Project

Submitted to:
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LIST OF ACRONYMS

APA/RP	Agency Preferred Alternative/ Recommended Plan
BMPs	Best Management Practices
CAP	Continuing Authority Program
CAR	Coordination Act Report
DPS	Distinct Population Segment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR/EIS	Integrated Feasibility Report / Environmental Impact Statement
FWCA	Fish and Wildlife Coordination Act
GI	General Investigation
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PA	Preferred Alternative
PDT	Project Delivery Team
PMP	Project Management Plan
PSAW	Puget Sound and Adjacent Waters Restoration Program
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
RP	Recommended Plan
Service	U.S. Fish and Wildlife Service

USACE	U.S. Army Corps of Engineers
VEC	Valued Ecosystem Component
WDFW	Washington Department of Fish and Wildlife
WDE	Washington State Department of Ecology
WRDA	Water Resources Development Act

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers, Seattle District (USACE) has completed a General Investigation study (GI) of nearshore ecosystem conditions throughout the approximately 2,466 miles of Puget Sound shoreline. The GI was initiated in 2001 by USACE and the local cost-share sponsor, the Washington Department of Fish and Wildlife (WDFW). The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) GI involved cooperation from numerous partners including federal, state, local, and tribal government representatives, as well as participants from non-governmental organizations and academic institutions. Results of the study are detailed in a series of 24 technical reports published by PSNERP, and summarized in an Integrated Feasibility Report and Environmental Impact Statement (FR/EIS).

Results of the GI include a characterization of nearshore ecosystem conditions and the articulation of a problem statement based on observed patterns of ecosystem degradation and habitat loss. USACE and partners derived restoration objectives to address identified problems. The PSNERP Project Delivery Team (PDT) screened numerous locally identified restoration concepts against planning objectives and identified restoration needs. Conceptual engineering designs were developed for 36 of these potential restoration actions to evaluate costs and benefits. Alternatives comprised of subsets of these 36 potential projects were analyzed and results documented in the FR/EIS. The initial draft FR/EIS was released for public and agency review in October 2014. During this review USACE revised the preferred alternative (PA) and recommend plan, reducing the number of potential projects proposed for immediate authorization through PSNERP. USACE also identified and categorized projects eligible for construction under existing authorities and programs. USACE places each of the 36 PSNERP projects into one of four potential construction categories as a "tiered approach" to implementation.

The revised agency preferred alternative/recommended plan (APA/RP) that USACE proposes to advance for PSNERP includes three projects that have sufficient level of analysis to move forward for implementation at this time. These three sites are the focus and outcome of the National Environmental Policy Act (NEPA) process and represent the primary scope of analysis for this Fish and Wildlife Coordination Act (FWCA) §2(b) Report:

- North Fork Skagit River Delta
- Nooksack River Delta
- Duckabush River Estuary

In addition to the three sites now proposed as the APA/RP, nine sites were determined to be potentially eligible for completion through a future USACE GI authority. However these projects currently lack sufficient engineering design and other detail sufficient for authorization at this time. Therefore, in addition to the three sites proposed for authorization, USACE has identified these nine sites as eligible for additional studies prior to a potential future request for authorization. Twelve of the 36 sites could be implemented through existing USACE programs or authorities and therefore do not require an additional request for authorization through PSNERP. The remaining 12 sites initially evaluated by the GI have already been implemented or are being addressed by other agencies. This tiered approach to implementation is the basis of the action proposed by USACE.

Systematic analysis completed by the PSNERP PDT provides a clear rationale for addressing the underlying causes of widespread nearshore ecosystem degradation and habitat loss. Large river deltas, smaller coastal embayments, and the bluff/beach systems that dominate the Puget Sound shorescape have all been widely impacted and are greatly diminished in quantity, quality, and connectivity relative to conditions in c.a. 1850. Numerous fish and wildlife resources that occupy the terrestrial/marine ecotone rely upon these productive ecosystems. Emblematic of the relationship between nearshore habitat loss and degradation are Pacific salmon species. While overfishing and upper watershed habitat impacts have contributed to the systematic decline in salmon production, estuarine wetland habitat loss, which averages 55% in Puget Sound, is a significant limiting factor for species recovery. Declines in populations of marine birds and other aquatic species show similar correlations between nearshore habitat loss and observed population declines. These observations support the conclusion of a compelling need for significant, large-scale nearshore ecosystem restoration. Puget Sound is clearly in need of restoration to improve habitat conditions for listed and non-listed fish and other aquatic species, and for general aquatic ecosystem health.

The APA/RP would significantly contribute to Puget Sound recovery. Skagit, Nooksack, and Hood Canal are priority areas for recovery and USACE proposes important advances in these regions by implementing over 2,100 acres of nearshore restoration focused in river deltas. These projects will provide numerous ecosystem benefits including habitat important for fish and wildlife resources. Adverse environmental effects associated with project construction are minor in scale and duration compared to ecosystem benefits. Most adverse effects can be significantly minimized by implementing standard best management practices (BMPs) including timing construction activities for periods when fish and wildlife are less likely to be present.

In fulfilling responsibilities of the U.S. Fish and Wildlife Service (Service) under the authority of the FWCA, this Coordination Act Report (CAR) includes recommendations to minimize potentially adverse effects and maximize benefits to fish and wildlife resources associated with the proposed actions. Recommendations considered essential for minimizing potential negative impacts and ensuring that intended benefits of the actions are realized include:

1. The Service recommends that USACE adhere to BMPs and conservation measures applicable to construction activities required to implement restoration projects. USACE should seek to avoid the need for variances and exceptions from practices that avoid or minimize adverse impacts to fish and wildlife resources.

2. The Service recommends that projects requiring replacement of highway and road bridges implement conceptual designs that avoid pile driving. Current plans specify that new bridge supports will be cast-in-place concrete piers to avoid noise impacts to aquatic species.

3. The Service recommends that riparian buffers installed by USACE restoration authorities and programs be consistent with the National Marine Fisheries Service (NMFS) guidelines for protection of salmon habitat functions.

4. The Service recommends that USACE and their partners exercise creativity and flexibility in working with landowners and other stakeholders in seeking to establish the maximum amount of ecosystem benefits from restoration projects.

5. The Service recommends that USACE continue to coordinate closely with tribal governments and entities with interest in these projects. In addition to compliance with requirements for formal government-to-government coordination, we strongly advise continued informal coordination with tribal government agency staff and tribal leaders.

6. The Service requests that USACE continue to engage with the Service and other natural resource agencies, seeking technical assistance to ensure that benefits to fish and wildlife resource are maximized and short-term adverse effects are minimized.

The Service supports the tiered approach for implementing USACE and WDFW projects that address the ecosystem restoration needs documented by the GI analysis. We specifically endorse:

1. Immediate implementation of the APA/RP. USACE and WDFW should continue engineering design and other tasks required to implement the three projects recommended by the GI. Completion of the Nooksack River, North Fork Skagit River, and Duckabush River projects will provide substantial positive benefits to Puget Sound recovery including important benefits for fish and wildlife resources.

2. Aggressive pursuit of opportunities to apply other USACE authorities to implement 12 projects identified by the tiered approach as appropriate for Puget Sound and Adjacent Waters (§544) or Continuing Authority Program (CAP) (§1135, §206) execution. These projects are within reach of existing authorities and resources and should be implemented as expeditiously as possible.

3. Simultaneous work to develop local sponsorship and USACE vertical team support for future GI studies to complete additional data collection and analysis required to advance nine projects determined suitable for GI implementation but lacking sufficient information for immediate authorization.

Our comments and recommendations have been prepared under the authority of and in accordance with the provisions of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). This is our final report and constitutes an official report of the Secretary of the Interior required under Section 2(b) of the FWCA. WDFW, NMFS, and Tribes directly affected by the USACE APA/RP were invited to provide input and participate in developing recommendations. WDFW and NMFS expressed support for Service recommendations and stated position. This final 2(b) report reflects comments received by Tribes and these agencies as detailed in correspondence to the Service.

I. INTRODUCTION

The USACE is proposing to implement the PSNERP in Puget Sound, Washington. Nearshore ecosystems have been severely degraded throughout Puget Sound and have been the focus of significant attention by federal, state, local, tribal, and private entities. Numerous species of anadromous fish, migratory birds, and other trust resources are dependent upon habitats provided by nearshore ecosystems. Western Washington tribes have asserted that habitat loss, including impacts to nearshore ecosystems, threatens salmon recovery efforts and the treaty protected rights that depend upon healthy salmon populations (NWIFC 2011). USACE proposes to implement a suite of actions to be delivered through PSNERP intended to restore ecosystem structure, function, and processes in Puget Sound for the benefit of native salmonids and other aquatic species.

USACE, in coordination with local cost-share sponsors (State of Washington, represented by the Washington Department of Fish and Wildlife), stakeholders, and the Service, identified numerous potential restoration activities throughout the GI study area. The study area encompasses the entirety of lower watersheds draining into Puget Sound including floodplains and river deltas (see Section II.B. for more detail) as well as the intertidal and nearshore subtidal shoreline of Puget Sound. USACE and their partners in the GI completed a comprehensive assessment of ecosystem conditions and nearshore habitat loss throughout the approximately 2,466 miles of Puget Sound shoreline (USACE 2014). This analysis informed the articulation of a problem statement and associated planning objectives to address observed patterns of ecosystem degradation. Over 500 restoration project concepts were evaluated against project objectives and ultimately 36 projects were carried through preliminary design and engineering. Subsets of these projects were used to define alternatives that are the subject of a Draft Integrated Feasibility Report / Environmental Impact Statement (FR/EIS) intended to represent the range of alternatives of a NEPA assessment. USACE, in conjunction with local sponsors, identified a recommended plan (RP) intended to represent the agency's preferred alternative (APA) of a NEPA assessment.

The purpose of this FWCA Report is to evaluate possible effects to fish and wildlife of proposed PSNERP projects identified as the APA/RP. The report includes recommended actions for minimizing deleterious consequences and maximizing benefits. In doing so, this report broadly evaluates effects within the study area of each alternative in the FR/EIS in order to concur with or dispute selection of the APA/RP. The report concludes with an overall recommendation from the Service supporting the tiered approach to implementation of restoration projects proposed by USACE.

Our comments and recommendations have been prepared under the authority of and in accordance with the provisions of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*). This is our final report and constitutes an official report of the Secretary of the Interior required under Section 2(b) of the FWCA.

A. Coordination with Federal and State Agencies and Tribal Governments

Since the initiation of the GI in 2001 by USACE and the WDFW stakeholder involvement and agency coordination have been vital components of PSNERP. A multi-disciplinary, multi-agency PDT has supported USACE and WDFW with development and execution of all aspects of the GI. The PDT comprises six standing teams with agency, non-governmental organization and other representatives serving on the Executive Committee, Steering Committee, Project Management Team, Nearshore Science Team, Implementation Team, and Stakeholder Involvement Team. A comprehensive list of PDT composition and affiliation, including Service participation, is provided in the FR/EIS (USACE 2014).

USACE has engaged in formal and informal coordination with the federally recognized tribes of the Puget Sound throughout the feasibility phase. In addition to direct tribal coordination the PDT has also included representation from the Northwest Indian Fisheries Commission. Coordination with tribes is ongoing and USACE will continue to offer opportunities to meet informally or through government-to-government meetings. Most recently USACE has met with tribes most directly affected by proposed projects. Tribal coordination will continue throughout the feasibility phase, preconstruction engineering and design, and construction.

Many project partners, the Washington State Governor, and five members of Congress have provided letters that express their support for PSNERP.

B. Project Authority, Purpose, and Scope

Proposed actions are the outcome of the Puget Sound Nearshore Ecosystem Restoration Study (Nearshore Study), which USACE is conducting under the authority of the River and Harbor Act of 1962 (Public Law 87-874). USACE initiated the reconnaissance phase in September 1999 and determined that there was sufficient federal interest to advance to the next stage of conducting GI. WDFW, as the non-Federal sponsor, and USACE initiated the feasibility phase of the study on September 25, 2001.

The purpose of the GI was to evaluate ecosystem degradation in the Puget Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend sites that have a Federal interest and the support of a local entity willing to provide necessary local cooperation. The Nearshore Study aims to address the continuing degradation of nearshore ecosystems through restoration of natural processes (e.g. sediment movement and tidal hydrodynamics) and restoration of coastal wetlands, embayments, and beaches.

The PDT identified three goals for restoration of the Puget Sound nearshore zone:

- Restore and protect nearshore processes that sustain the ecological health of Puget Sound;
- Restore and protect ecosystem functions and structures that support valued ecosystem components (VECs); and
- Increase understanding of the Puget Sound nearshore zone to improve restoration and protection actions.

C. Prior Efforts and Coordination with the Service

USACE initiated consultation with the Service under the authority of FWCA in 2002, shortly after the start of the GI Feasibility Phase. The Service has provided three Planning Aid Letters (2005, 2007, and 2011) and provided a Service biologist to be a member of the Nearshore Science Team and the Steering Committee. The Service has been supportive of Nearshore Study efforts and USACE has been incorporating Service technical advice into project planning, strategies, objectives, site screening, and conceptual designs.

A Service report (USFWS 2011) supporting the formulation of a Nearshore Study PA includes information on federally listed threatened or endangered species under the Endangered Species Act (ESA) for each of the 18 sites evaluated. In our report the Service provided a species list and a species-specific and general conservation measures from the Programmatic Biological Assessment and Biological Opinion for Fish Passage and Restoration Actions in Washington State (NMFS and USFWS 2008). USACE, NMFS, and the Service are revising this programmatic consultation to cover all types of actions proposed by the Nearshore Study team with expected completion in 2016.

D. Prior Studies and Reports

USACE has conducted other GIs and has implemented other ecosystem restoration projects around Puget Sound prior to initiating the Puget Sound Nearshore Study (see Tables 1.7.1 and 1.7.2 from USACE 2014). These include the Puget Sound and Adjacent Waters Restoration Program (PSAW) which was authorized by §544 of the Water Resources Development Act (WRDA) of 2000. While this authority has not been fully utilized due to the lack of a supporting GI, directed funds have been used to implement several nearshore restoration projects. Projects implemented under PSAW include the Qwuloolt ecosystem restoration project and Seahurst Beach restoration Phases 1 and 2. PSAW authorization includes an upper limit of $40M in federal funding available through the life of the authority and per-project caps ($5M federal funding). Projects proposed under PSNERP would exceed these limits thus rendering PSAW insufficient to meet the needs identified by the PSNERP GI. Similarly, Corps of Engineers Continuing Authorities Programs (CAPs), including §1135 of WRDA 1986 and §206 of WRDA 1996, have been used to implement smaller restoration projects in Puget Sound and contributing watersheds. These programs are also constrained in their ability to deliver large-scale restoration actions proposed by PSNERP with per-project spending limits ($10M in federal funding).

In support of the GI PSNERP produced 24 peer reviewed technical reports. These reports documented study approach and results as well as establishing the conceptual framework upon which this ecosystem approach to restoration was based. Documents can be accessed on the program's website: http://www.pugetsoundnearshore.org/technical_reports.html.
A subset of these technical reports forms the basis for the USACE definition of planning objectives and project selection strategy, and is highlighted in the Chapter 12 of the FR/EIS (Annotated Bibliography). These principal PSNERP technical reports include:

> *Principles for Strategic Conservation and Restoration.* This report summarizes principles of landscape ecology and conservation biology that are applicable to the conservation and restoration of nearshore ecosystems in the Puget Sound and are

intended to guide the prioritization of sites and actions by the PDT and others (Greiner 2010).

Historical Change and Impairment of Puget Sound Shorelines: Atlas and Interpretation of Puget Sound Nearshore Ecosystem Restoration Project Change Analysis. This report is a comprehensive, spatially-explicit analysis (Change Analysis) of net changes to nearshore ecosystems of Puget Sound—its beaches, estuaries, and deltas—since its earliest industrial development. This Change Analysis report provides the spatially explicit analysis that identifies impacts to Puget Sound. These data were used to both quantify Sound-wide conditions and identify site-specific restoration needs and opportunities (Simenstad *et al.*, 2011).

Implications of Observed Anthropogenic Changes to the Nearshore Ecosystems in Puget Sound. This report presents a synthesis of the most significant physical changes to the nearshore ecosystems of Puget Sound and implications of these changes to ecosystem functions, goods, and services. This document served as the basis for definition of the Problem Statement for PSNERP and the rationale for ecosystem restoration objectives (Fresh *et al.*, 2011).

Strategies for Nearshore Protection and Restoration in Puget Sound. This report presents a model for integrating change analysis and estimating ecosystem degradation. This model is applied to evaluate potential delta, beach, barrier embayment, and coastal inlet restoration sites (Cereghino *et al.*, 2012)

The basis for design concepts and initial engineering for a suite of 36 potential nearshore restoration projects is presented in a contractor's report to the study: *Strategic Restoration Conceptual Engineering — Final Design Report* (ESA 2011), also available on the program website: http://www.pugetsoundnearshore.org/cdr.html

There is also a series of four documents produced by the Service with contractor support to supplement Nearshore Study conceptual design work and includes the following:

PSNERP Strategic Restoration Conceptual Design Preliminary Environmental Contaminants, Cultural Resource, and Endangered Species Site Evaluations. This report provides baseline information on environmental contaminants, cultural resources, endangered species, and conservation measures for 36 candidate restoration sites under consideration by the Nearshore Study team. Environmental Site Assessment Level 1 Survey Checklists were also completed for each of the 36 sites (USFWS 2011).

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington, Task - Literature and Data Review and Synthesis. This report presents the results of cultural resource record/literature searches for 36 candidate restoration sites under consideration by the Nearshore Study team. An assessment of the potential for cultural resources within each project area is made based on a review of the environmental, cultural, and archaeological data. Recommendations

are provided on where future archaeological efforts should be made for each of the 36 areas of potential effect.

A Cultural Resources Assessment of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP) Area, NW Washington - Task 2: Historic Context of Agricultural Dikes. This report is a regional-scale historic context of late nineteenth and early twentieth century agricultural development within the Puget Sound region of northwest Washington. This report documents the history of development of dikes built in the region, and proposed evaluation criteria to use as a management tool for Service and others to use for future compliance with Section 106 of the National Historic Preservation Act (NHPA).

Cultural Resources Field Inventory for 15 Action Areas within the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Area, NW Washington. This report presents the findings of both surface surveys and subsurface investigations concentrated on project components within areas previously determined to have high to moderate probabilities for cultural resources. The purpose of the inventory was to provide (1) descriptions of cultural resources in the area of potential effect (APE) for Nearshore Study undertakings, (2) determinations concerning the eligibility of cultural resources to the National Register of Historic Places (NHRP) and the Washington Heritage Register (WHR), and (3) recommendations on how to avoid or mitigate impacts to historic properties. This report was completed for subset of the 36 candidate restoration sites and only on lands where access had been granted by the landowner.

E. State Agency, National Marine Fisheries Service, and Tribal Coordination

The WDFW, NMFS, and Tribes directly affected by the USACE APA/RP were invited to provide input and participate in developing recommendations. A draft version of the CAR was provided to WDFW, NMFS, and affected Tribes. This report reflects concerns expressed by Tribes and these agencies, as detailed in correspondence to the Service (Appendices A through C).

1. Washington Department of Fish and Wildlife

In their letter dated February 11, 2016 (Appendix A), WDFW expresses support for Service recommendations and statements provided in this CAR. WDFW notes that they are actively working on the development of riparian guidance tools. WDFW, as local sponsor of proposed PSNERP actions, indicates that they will rely on this updated scientific guidance prior to concurring with our recommendation for adherence to NMFS riparian buffer guidelines stated in Section IX(A)(3) of this report.

2. National Marine Fisheries Service

In the email dated February 16, 2016 (Appendix B), the North Puget Sound Branch of the Oregon Coast Area Office of NMFS expressed strong support for Service findings and recommendations presented in the CAR. NMFS noted their recent completion of formal

consultation under §7 of the ESA for the three projects proposed by USACE. These projects were identified in NMFS salmonid recovery plans, and the agency believes that the projects will have substantial benefit for the conservation of affected ESA listed salmon and steelhead.

NMFS also suggested inclusion of a procedural consideration in the final CAR consistent with recommendations provided in their formal consultation. Specifically:

> "*NMFS recommends that the COE provide detailed design information for each of four stages of design development identified in PSNERP program: 1) Concept (10 percent); 2) 30 percent design; 3) 60 percent design; and 4) 90 percent design.*"

NMFS finds that provision of additional design information as projects progress towards completion will enable their agency to ensure that the ESA consultation completed for these projects remains valid. This on-going coordination will allow NMFS to determine if the incidental take statement remains sufficient to cover proposed actions and associated effects to ESA listed species or if new information has emerged which might trigger the need to reinitiate consultation.

This request is consistent with our more general recommendation for on-going coordination as stated in Section IX(A)(6) of the CAR. The Service supports this recommendation from NMFS, and requests USACE to coordinate with NMFS on a process to provide additional design information to ensure continued compliance of the proposed actions with §7 of the ESA.

3. Swinomish Indian Tribal Community

In the letter dated February 5, 2016 (Appendix C), the Swinomish Tribal Environmental Policy Director identifies concerns associated with potential impacts to tribal fishing sites associated with the North Fork Skagit River Delta project. The letter notes that the project was identified by the Tribe as an important option for estuarine restoration as part of the Skagit Chinook Recovery Plan. While indicating support for projects that contribute to Chinook and steelhead recovery, the Tribe seeks the opportunity to better understand how this section of the river will evolve with or without the project. Specifically, the Tribe raises concerns about effects of river changes on navigation, shoreline access, and associated impacts to Tribal fishermen. The Tribe requests inclusion in the development of future analysis of the project and the final project design.

This request is consistent with our recommendation for USACE coordination with tribal governments with interest in these projects as stated in Section IX(A)(5) of the CAR. The Service supports this request, and recommends that USACE coordinate with the Swinomish Tribe in assessing potential impacts to Tribal fisheries and in the Tribe's participation in future design phases for this project.

II. DESCRIPTION OF STUDY AREA AND ACTION AREA

A. Puget Sound Context

The waters of Puget Sound cover nearly 17,000 square miles, a watershed collectively referred to as the Puget Sound Basin. This basin is bordered on the east by the Cascade Mountains and on the west by the Olympic Mountains. The Puget Sound Nearshore Study area consists of the nearshore zone of the Puget Sound Basin including Puget Sound, the Strait of Juan de Fuca, and southern portions of the Strait of Georgia that occur within the borders of the United States (Figure 1). Headwaters for two of these basins originate just north of the border in Canada. The study area shoreline is approximately 2,466 miles in length. The basin is roughly 80 percent land and 20 percent water. The total water area covers nearly 3,090 square miles at mean high water. The region's soils are characterized as immature, being less than 10,000 years old. Typical of fjords, water depths in Puget Sound increase rapidly from shore, with an average depth of 200 feet and a maximum depth of more than 1,200 feet. (USACE 2014).

The structures and habitats of Puget Sound are a complex mixture of beaches and bluffs, estuaries, lagoons, river deltas, and rocky coastlines. Shipman (2008) defines a classification of Puget Sound nearshore landforms that reflects the primary role of geomorphic processes in shaping the landscape. This classification system identifies four geomorphic systems that form the foundation of this shoreline classification. Three of these systems (beaches, embayments, and river deltas) reflect differences in the roles of waves, tides, and rivers in transporting sediment and shaping the coastline. The most common Puget Sound shoreline type consists of mixed sand and gravel beaches backed by high coastal bluffs. Other sediment dominated shoreline environments include large river deltas, tidal flats, salt marshes, and estuaries. A fourth system, rocky coasts, is characterized primarily by the limited availability of mobile sediment and the lack of major depositional landforms. Rocky-bottom habitat is less common than soft-bottom habitat and is confined mostly to northern Puget Sound. The shorelines of the San Juan Islands exemplify rocky coast systems in Puget Sound (Shipman, 2008).

Widely varying fish communities utilize Puget Sound nearshore ecosystems where individuals spend all or portions of their lives. In general they are grouped as demersal/reef fish, forage fish, and anadromous fish. Fifteen native species of anadromous fish use marine and freshwater habitats of the Puget Sound area. These include all five species of Pacific salmon (pink - *Oncorhynchus gorbuscha*, coho – *O. kisutch*, chum – *O. keta*, Chinook – *O. tshawytscha*, and sockeye – *O. nerka*), two species of native char (bull trout - *Salvelinus confluentus* and Dolly Varden – *S. malma*), steelhead (*O. mykiss*) and coastal cutthroat trout (*Oncorhynchus clarkii clarkii*), longfin smelt (*Spirinchus thaleichthys*), eulachon (*Thaleichthys pacificus*), white (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*), and Pacific lamprey (*Entosphenus tridentatus*) and river lamprey (*Lampetra ayresii*). Numerous anadromous fish populations are listed as threatened or endangered under the ESA in Puget Sound, with habitat loss cited as a threat limiting species recovery.

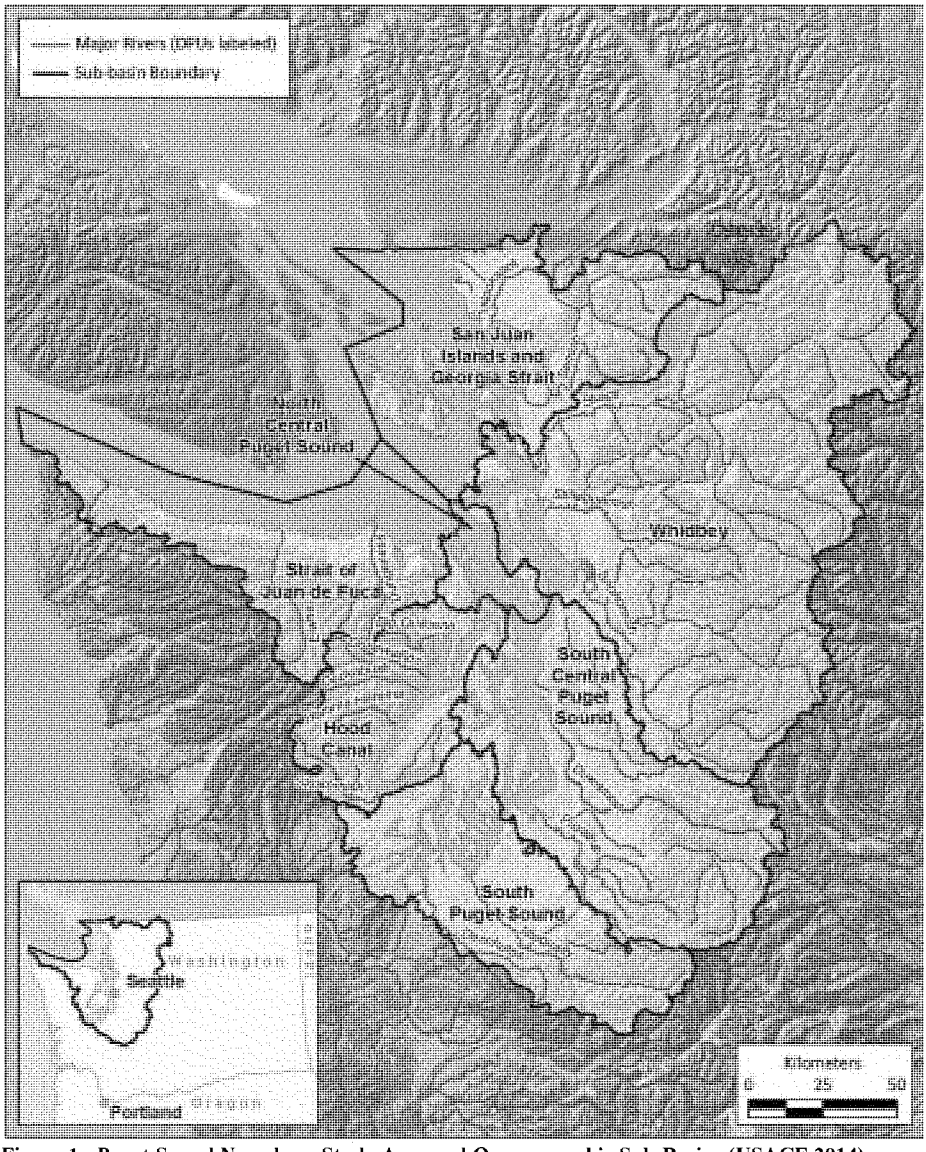

Figure 1: Puget Sound Nearshore Study Area and Oceanographic Sub-Basins (USACE 2014).

B. Study Area and Action Area

For the purpose of this project the study area has been divided into seven sub-basins based on geographic features including oceanographic sills and bathymetry, common issues and interests of the entities in these areas, and water flow patterns (Figure 1). Generally consistent with other delineations of greater Puget Sound, these sub-basins include:

- Strait of Juan de Fuca
- San Juan Islands – Georgia Strait
- Hood Canal
- North Central Puget Sound
- Whidbey
- South Central Puget Sound
- South Puget Sound

Five of these sub-basins are included within the watershed area of Puget Sound proper. The other two study area sub-basins include areas of the Strait of Juan de Fuca and the Georgia Strait seaward to the international boundary. Within these sub-basins, the study area consists of the entire extent of the nearshore zone, which includes beaches and the adjacent tops of coastal banks or bluffs, the shallow waters in estuarine deltas, and tidal waters from the head of tide to a depth of approximately 10 meters relative to the mean lower low water level (Figure 2). This contiguous band around the shoreline of the entire study area hosts diverse ecosystems that are shaped by coastal geomorphology and local environmental conditions, such as wave energy and salinity.

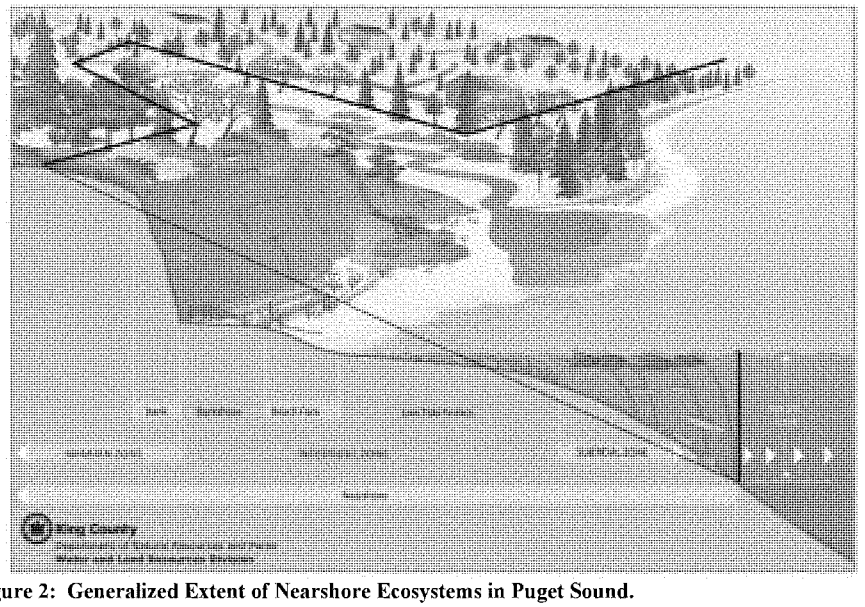

Figure 2: Generalized Extent of Nearshore Ecosystems in Puget Sound.

III. FISH AND WILDLIFE RESOURCES AND PLANNING OBJECTIVES

A. General Fish and Wildlife Concerns

Led by an interdisciplinary Nearshore Science Team, USACE, WDFW, and other project partners completed a comprehensive, spatially explicit assessment of the extent of change throughout Puget Sound's shorelines, estuaries, and deltas. This Change Analysis (Simenstad *et al.*, 2011) quantified structural and physical change between historical (ca. 1850s – 1890s) and current (ca. 2000 – 2006) conditions along the entire 2,466 miles of Puget Sound shoreline and corresponding 13,930 square miles of drainage area. Observed changes were subsequently analyzed to characterize the impacts of shoreline and watershed alterations on nearshore ecosystem processes, identify the fundamental causes of the observed ecosystem degradation, and assess which of the causes most need to be addressed in this feasibility study through restoration and protection alternatives (Schlenger *et al.*, 2011a). Conceptual models were used to connect alterations of critical ecosystem processes and the resulting habitat loss to a representative subset of socially relevant fish and wildlife resources referred to as "VECs". A series of white papers authored by species experts summarized scientific literature documenting these species/habitat relationships for VECs, including:

- Kelp and eelgrass (Mumford 2007)
- Marine riparian vegetation (Brennan 2007)
- Native shellfish (Dethier 2006)
- Forage fish (Penttila 2007)
- Juvenile salmon (Fresh 2006)
- Orca whales (Kriete 2007)
- Nearshore birds (Buchanan 2006)
- Great blue herons (Eissinger 2007)

Integration of these observed changes in nearshore ecosystem, identification of fundamental causes of degradation, and documented species/habitat relationship provided the technical basis for the definition of a problem statement. In the USACE planning process followed in the GI study, an understanding of ecosystem problems leads to establishment of planning objectives, against which restoration opportunities can be evaluated for effectiveness, efficiency, and feasibility. The problem statement defined by the Nearshore Science Team for the study is summarized by Fresh *et al.*, (2011):

1. Large river deltas have been widely impacted by multiple alterations that significantly limit the size of the estuaries and degrade the nearshore ecosystem processes that support them.
2. Many coastal embayments, including open coastal inlets, barrier estuaries, barrier lagoons, and closed lagoons/marshes, have been eliminated or disconnected from Puget Sound by the placement of fill, tidal barriers, and other stressors.
3. Stressors along beaches and bluffs have disconnected sediment inputs and altered sediment transport and accretion along long sections of the Puget Sound shoreline.

4. Estuarine wetlands have been extensively lost throughout Puget Sound including a loss of 56% in the 16 largest river deltas. In particular oligohaline and freshwater tidal wetlands have been almost completely eliminated (loss of 93%) in Puget Sound.
5. The shoreline of Puget Sound has become much shorter and simpler, as well as more artificial. Since Europeans began settling the region, Puget Sound's shoreline has had a net decline of 15% in length. Artificial landforms now represent 10% of the shoreline of Puget Sound.
6. Large portions of Puget Sound have been altered by multiple types of changes that may cumulatively combine to severely degrade nearshore ecosystem processes. Approximately 40% of the shoreline of Puget Sound has been altered by one or more stressor (e.g., overwater structures, roads, marinas, fill, armoring etc.).

1. Large River Deltas

PSNERP study documents conclude that barriers to tidal hydrology and shoreline armoring were the primary stressors impacting river delta ecosystems in Puget Sound. All of the 16 largest deltas of Puget Sound have been extensively modified with an estimated total loss of shoreline of 109 miles or 27% from historical conditions. Changes to the wetlands of the large deltas have been especially dramatic. In aggregate 56% of the historical wetlands (57,823 acres) of Puget Sound river deltas have been eliminated (Simenstad *et al.,* 2011).

USACE (2014) notes that these impacts have diminished the availability of habitat for numerous plant and animal species. Shorebirds that utilize estuarine tidal flats for feeding, roosting and reproduction have been adversely impacted by loss of river delta habitats (Buchanan 2006). Diking and filling of delta ecosystems has decreased tidal channel habitat, restricting fish and wildlife to less area. The Duwamish and Puyallup estuaries have been simplified to a single channel, concentrating fish, limiting ability to avoid predation, and reducing overall carrying capacity. While less severe than these urban estuaries, all large river deltas elsewhere in Puget Sound have been similarly degraded with the simplification of historically complex and dynamic tidal channel systems.

2. Coastal Embayments

Throughout Puget Sound small coastal embayments have been eliminated by filling or have been disconnected from the nearshore zone by fill causeways, tide gates, or diversions. PSNERP analysis mapped the location of 884 historical embayments. The current condition includes 579 mapped embayments, a net loss of 305 of these critical "pocket estuaries" in Puget Sound. Embayments historically accounted for 689 miles of Puget Sound shoreline (23%) but now account for 375 miles of shoreline (15%); this represents a decline in length of 46%. Many remnant embayments have been modified, reduced in area by encroaching fill or impacted by shoreline armoring. Approximately 18% of the remaining shoreline associated with coastal embayments is armored (Simenstad *et al.,* 2011).

The sheltered condition of embayments makes them important habitat for native shellfish, fish, and shorebirds. Embayments provide cover and a food-rich environment for several species of juvenile fish during their migration along the shore from natal streams to the Pacific Ocean. Recent evidence from the Whidbey Sub-basin shows that large numbers of post-larval and

juvenile surf smelt rear in "pocket estuaries" (Beamer *et al.*, 2006). During late winter and early spring large numbers of juvenile Chinook and chum salmon rear in pocket estuaries of the Whidbey Sub-basin.

3. Beach and Bluff Systems

Puget Sound beaches have been broadly impacted by modifications with armoring (seawalls and revetments) observed as the most pervasive direct alteration. Armoring occurs along one-third of bluff-backed beaches and over a quarter of barrier beaches; 34% of all bluff-backed beaches are armored along more than half of their length. Only 25% of all bluff-backed beaches are completely unarmored. The distribution of armoring associated with beaches varies greatly among sub-basins with nearly 63% of the shoreline armored along the highly developed shores of south central Puget Sound between Tacoma and Everett. In addition to armoring, roads and nearshore fill are the most significant stressors affecting beaches in Puget Sound (Schlenger *et al.*, 2011a)

Shoreline armoring and other changes to beaches and bluffs have resulted in the loss of sediment supply (sand and gravel). The resulting interruption of sediment transport processes has impacted beaches and increased vulnerability to wave erosion and changes in sea level. Disruptions in sediment processes can also change the physical characteristics of a beach, including changes in sediment composition (e.g. coarsening), steepening of beach slopes, and narrowing of beach width (Shipman *et al.*, 2010). These changes decrease the quantity of beach habitat available, and sediment composition changes can lead to decreased availability of fine grained substrates needed for shellfish, probing shorebirds, and beach-spawning fish.

In addition to loss of fine-grained material that beach-spawning fish require, armoring can affect reproduction of forage fish in several ways. Armoring low in the intertidal zone can directly eliminate the spawning habitat of several species (e.g. surf smelt and sand lance) that spawn on the upper beach (Penttila, 2007). Armoring can also increase sediment temperatures on the upper beach where shading by natural shoreline vegetation has been removed; reducing survival of incubating embryos (Rice, 2006). In addition to effects on reproduction of forage fish, armoring can affect feeding behavior of juvenile forage fish (as well as juvenile Pacific salmon) that often feed in shallow water at high tide. When shoreline modifications extend lower on the shore the truncation of intertidal shallow water habitat by armoring reduces foraging by juvenile fish on riparian insects (Toft *et al.*, 2007).

4. Estuarine Wetlands

Eighty percent of historic Puget Sound estuarine wetlands were associated with the 16 large deltas; the remainder were associated with embayments. Historically delta system wetlands supported nearly 103,000 acres of estuarine wetlands compared to the current 45,220 acres, a decline of 56%. Coastal embayments have been similarly impacted with a loss of 69% of historic wetlands; only 8,229 acres remain. Tidal freshwater and oligohaline transitional wetlands (i.e. tidal forests and swamps) have been nearly eliminated; over 90% of these two wetland types have been lost throughout Puget Sound (Simenstad *et al.*, 2011). Based on land cover projections from Bolte and Vache (2010) losses of tidal wetlands are expected to continue.

5. Shoreline Simplification

The shoreline of Puget Sound has become shorter and simpler (i.e. straighter, less complex) over the past 150 years. Throughout the Puget Sound basin the net loss of shoreline length has been 431 miles, resulting in a current shoreline that is about 15% shorter than it was historically. While more than 600 miles of natural shoreline was eliminated, 229 miles of artificial shoreline (i.e. seawalls backed by fill) was added. Although the historic length of shoreline classified as artificial was negligible, artificial shoreline built by a modern industrial society now represents about 10% of the total length of shoreline in Puget Sound (Simenstad *et al.*, 2011).

6. Cumulative Effects

Many of the altered shoreline segments around Puget Sound have not just one, but multiple types of human-caused alterations. Only 14% of the project area is not impacted by a shoreline stressor. Of the nine shoreline stressors considered in the Nearshore Study armoring is clearly the dominant stressor, occurring in 78% of all shoreline segments analyzed. Although no shoreline segment was impacted by all nine stressors, 81% of segments have more than one type of stressor. It is highly likely that cumulative effects are negatively affecting nearshore ecosystem functions (Simenstad *et al.*, 2011).

B. Planning Objectives

Based on the analysis described above and in direct response to the identified problems of observed nearshore ecosystem degradation, the study team developed four planning objectives with associated sub-objectives to guide the formulation of alternative plans (USACE 2014). The planning objectives articulate the goal of PSNERP to restore the physiographic processes that sustain the Puget Sound nearshore ecosystem and its broad array of nationally and regionally significant resources. Through process restoration the project aims to sustainably address impairment to the nearshore zone's ability to deliver ecosystem functions, goods, and services, and to support VECs. Planning objectives most directly address the first three problem statements described above and indirectly address the others. The planning objectives are:

1. Restore connectivity and size of large river delta estuaries.
2. Restore the number and quality of coastal embayments.
3. Restore the size and quality of beaches.
4. Increase understanding of natural process restoration in order to improve effectiveness of project actions.

C. Current Status of Fish and Wildlife Resources

1. Federally Listed Species

In coordination with the Service, USACE has identified 13 fish and marine mammals within the study area listed as threatened or endangered under the ESA. Information provided by the Service was used by USACE to analyze potential impacts for proposed restoration actions

(USFWS 2011). Recovery plans for eight of the ESA-listed species have been or are being developed by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service. Actions proposed by the Nearshore Study support salmon recovery consistent with NOAA's salmon recovery plans.

Federal ESA-listed species and/or the habitat suitable to support these species which may occur in the study area include the following:

- Bocaccio
- Canary rockfish
- Yelloweye rockfish
- Eulachon
- Hood Canal summer chum salmon
- Puget Sound Chinook salmon
- Coastal/Puget Sound bull trout
- Puget Sound steelhead trout
- Green sturgeon
- Southern resident killer whale (Orca)
- Humpback whale
- Marbled murrelet
- Golden paintbrush

Information on listing status, use of the nearshore zone of Puget Sound, and factors that have led to their decline is presented in the FR/EIS and discussed in further detail in supporting documents, including *Appendix F: Supplemental Information on the Affected Environment* (USACE 2014). Pertinent information for these ESA listed species is summarized below.

a. Boccacio, Canary, and Yelloweye Rockfish

Bocaccio (*Sebastes paucispinis*) are a rockfish species that range from northern British Columbia to central Baja California. Pelagic juveniles are known to occur along margins of nearshore ecosystems containing rocky substrate with kelp or sandy areas supporting eelgrass. Primary threats are associated with adult mortality from direct fishing and bycatch of this long-lived species. Overharvest led to recruitment failure in the early 1900s. Due to declining numbers and increased rarity, bocaccio is ESA-listed as endangered (NMFS 2009).

Canary rockfish (*Sebastes pinniger*) range from northern British Columbia to northern Baja California. Yelloweye rockfish (*Sebastes ruberrimus*) have an overlapping range with a slight northward shift in distribution from the eastern Aleutian Islands to Northern California. Both species can be very long-lived, with adult canary rockfish potentially living to be 80+ and yelloweye rockfish slightly longer. Adult canary rockfish occupy relatively deep marine environments, observed in depths of 250 to 650 meters in areas with considerable current around pinnacles and high relief rock. Yelloweye rockfish are associated with somewhat shallower, similar rocky marine areas with refuge such as crevices, caves, and boulder piles. Occasionally they will wander onto mudflats adjacent to rocky areas in shallower waters. As with boccacio,

juveniles are pelagic drifting with coastal currents over nearshore areas. Both rockfish species are ESA-listed as threatened due to declining numbers and increased rarity. Threats to these species of rockfish are the same as those for bocaccio. There are no Federal recovery plans for these three species of rockfish. WDFW has a Rockfish Conservation Plan that focuses on managing fisheries, establishing marine conservation areas, reporting and removing fishing gear, and exploring hatchery program and artificial reefs. They also publish recommendations to limit bycatch and mortality from recreational angling (WDFW 2012).

b. Eulachon

Eulachon (*Thaleichthys pacificus*) are a small anadromous fish that range from California to Vancouver Island including northern Puget Sound. Threats to eulachon include habitat loss and degradation of spawning grounds via dams, siltation, and dredging, and potentially chemical pollution (Gustafson *et al.*, 2010). The southern Distinct Population Segment (DPS) of eulachon is ESA-listed as threatened (NMFS 2010). There are no formal recovery plans for eulachon.

Eulachon spend most of their lives in the nearshore zone before migrating into the major river systems along the west coast of North America to spawn in the early spring (late February to May). No spawning areas are documented in Puget Sound. The only documented eulachon spawning near the project area is the Elwha River in the Strait of Juan de Fuca (designated as critical habitat) (NMFS 2011). It is believed that eulachon return to the estuary of their birth but it is not known if they return to the same river from where they hatched. After hatching larvae are carried downstream and out into the estuary where they feed on zooplankton.

c. Hood Canal Summer Chum Salmon

Chum salmon (*Oncorhynchus keta*) range from Monterey, California to the Arctic coast and Beaufort Sea along the west coast of North America. While chum stocks in greater Puget Sound are relatively stable six of the eight summer chum salmon stocks within the Hood Canal Evolutionarily Significant Unit (ESU) were decreased in abundance with return stocks below viable replacement levels in the early 1990's (Fresh 2006). Threats to Hood Canal summer-run chum salmon include nearshore habitat loss and degradation, harvest, and low water flows in Hood Canal watersheds (Johnson *et al.*, 1997). Based on declining run sizes and threats to continued survival of this unique run the Hood Canal summer-run chum salmon ESU was ESA-listed as threatened in 1999 (NMFS 2005a). Subsequent harvest rate declines and recovery action implementation have contributed to stabilized and increasing run sizes. Reintroduction programs also appear to be succeeding with natural-origin spawners returning to two streams where summer chum had been extirpated for more than 10 years (Adicks *et al.*, 2007).

Unlike other salmonids that rear in natal freshwater streams and rivers juvenile chum salmon migrate quickly to marine waters after hatching. When the fry first enter saltwater they assemble in small schools and reside close to shore where they can avoid predators and forage on epibenthic prey. Juvenile chum salmon often use small coastal embayments and eelgrass beds as foraging areas and refuge from predators. As the young fish grow they gradually move to deeper water and generally migrate towards open ocean. Some chum salmon juveniles will remain in

the nearshore zone until late in their second year before migrating to the open ocean. These generalized life history characteristics make chum salmon relatively more dependent upon nearshore ecosystems for juvenile and adult growth and survival (Fresh 2006).

d. Puget Sound Chinook Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) range from central California to Kotzebue Sound, Alaska along the coast of North America. Abundance estimates for the Puget Sound ESU east of the Elwha River indicate that most populations are at a small fraction of their historic levels; several populations within the Nooksack, Lake Washington, mid-Hood Canal, Puyallup, and Dungeness basins have returns of fewer than 200 adult fish signifying extinction risk. Only the upper-Skagit stocks have returns of native (non-hatchery) fish in excess of 10,000 adults. A 1998 status review of these populations indicated a decline of 1.1 percent per year; more recent calculations indicate a slower decline (Shared Strategy 2007). Identified threats to Puget Sound Chinook salmon include degradation and loss of estuarine wetlands utilized by juveniles, sedimentation of upper tributary spawning reaches from forest management, and fish passage barriers and altered hydraulic flows from dams that limit access to habitat (Good *et al.*, 2005). The Puget Sound Chinook salmon ESU is ESA-listed as threatened (NMFS 2005a). Critical habitat exists throughout Puget Sound and its tributaries.

Chinook within the range of the study area exhibit a wide range of variability in life history including duration of freshwater residence for juveniles following emergence, variation in age of downstream migration (both within and between watershed-specific stocks), ocean distribution and ocean migratory patterns, and variation in age of spawning migrations. Downstream migration of juveniles and associated relative importance of freshwater or estuarine habitats for rearing can be generalized as stream-type and ocean-type life histories (Healey 1982). Stream-type populations may rear as juveniles in freshwater streams for one to three years prior to migrating downstream to marine waters. Ocean-type populations migrate within their first year relying on estuarine and nearshore marine habitats for juvenile rearing, including foraging and refuge from predation. Among the ocean-type populations of the Skagit River, Beamer and Larsen (2004) found a density-dependent relationship and displacement of fry migrants due to lack of estuarine habitat capacity. Juveniles arriving later in the season were unable to access high quality tidal channel and marsh habitats because earlier migrants occupied these areas. These late arrivals were forced downstream into marine nearshore areas with lower prey resource availability and higher predation rates, decreasing survival rates for this segment of the population. Presumably greater abundance of estuarine habitats would have led to overall increases in juvenile survival, and by extrapolation, adult returns and run size.

The Shared Strategy for Puget Sound facilitated development of a plan for Puget Sound salmon recovery organized by local watershed planning areas. The recovery plan has been adopted by NMFS and focuses on habitat restoration, harvest regulations, and interaction with hatchery fish (Shared Strategy 2007). Responsibility for the oversight of Puget Sound Chinook recovery plan implementation transferred to the Puget Sound Partnership in 2008.

e. Coastal/Puget Sound Bull Trout

Bull trout (*Salvelinus confluentus*) are native char of Washington, Oregon, Idaho, Nevada, Montana, and western Canada. Combinations of factors including habitat degradation, expansion of exotic species, and exploitation have contributed to the decline and fragmentation of bull trout populations. Puget Sound bull trout are ESA-listed as threatened (USFWS 1999). Critical habitat exists throughout much of Puget Sound and its tributaries. The Federal Draft Recovery Plan for Puget Sound Bull Trout focuses primarily on habitat including water quality and temperature (USFWS, 2004).

Eight bull trout core areas have been defined for watersheds along the eastern side of Puget Sound (Chester Morse Lake, Upper Skagit, Lower Skagit, Nooksack, Puyallup, Snohomish/Skykomish, Stilliguamish, and Chilliwack). Six populations on the Olympic Peninsula are limited to the Strait of Juan de Fuca and Hood Canal (Dungeness, Elwha, Hoh, Queets, Quinault, and Skokomish). Each core area has associated populations within it that exhibit varying life history types and spawning areas. Currently, no bull trout populations are known to use tributaries or estuaries on the western side of Puget Sound.

Bull trout are a wide-ranging species with multiple life history forms and a complex population structure reflecting a high degree of local site fidelity (Kanda and Allendorf 2001) and substantial genetic divergence between populations (Dunham and Rieman 1999; Spruell and Maxwell 2002). This diversity makes generalizing bull trout use of nearshore areas difficult. Bull trout have migratory and resident life history strategies. Residents spend their entire life cycle in the tributary streams in which they spawn and rear, whereas migratory forms rear in freshwater and then migrate to either a lake (adfluvial), a river (fluvial), or to saltwater (anadromous) (USFWS 2004). Unlike Pacific salmon anadromous bull trout are year-round residents of the Puget Sound basin. In marine areas sub-adult and adult bull trout commonly forage in shallow nearshore habitat and natal and non-natal estuaries along the shoreline. Primary prey items include surf smelt, sand lance, Pacific herring and juvenile salmonids.

f. Puget Sound Steelhead

Steelhead (*Oncorhynchus mykiss*) range from Kamchatka in Asia, east to Alaska, and south along the Pacific Coast to southern California (Busby *et al.*, 1996). Rapid declines have been observed over the past 10-plus years in Puget Sound steelhead populations with marked decreases observed within the Strait of Juan de Fuca, Bellingham Bay, Hood Canal, and south Puget Sound. Speculated causes of these declines include climate change, hatchery production, harvesting, and increased UV radiation (Hard *et al.*, 2007). Puget Sound steelhead are ESA-listed as threatened (NMFS 2007b). There are currently no recovery plans for Puget Sound steelhead.

Relative to the longer nearshore rearing periods of other juvenile salmonids, juvenile steelhead smolts generally outmigrate from natal streams to offshore areas rapidly. Once in saltwater, they quickly move into deeper water, and the transit time through the Puget Sound to the ocean is brief (15 to 25 days). Their diet while in Puget Sound is largely unknown due to lack of

samples, but they are thought to eat squid and small fish (Goetz, pers. comm. 2012) Few reference sources discuss estuarine use by steelhead adults.

g. Green Sturgeon

Green sturgeon (*Acipenser medirostris*) are broadly distributed from Mexico to Alaska along the coast of North America. After completion of a study of its status (Adams *et al.*, 2002) NMFS determined that the green sturgeon is comprised of two DPSs that qualify as species under the ESA. In 2002 NMFS determined that the Northern DPS was not warranted for listing as threatened or endangered (NMFS 2002). The Southern DPS of green sturgeon is ESA-listed as threatened (NMFS 2006a). Threats to the listed entity are primarily attributed to reduction in spawning area to a limited number of rivers including the Sacramento, Rogue, and Klamath; limiting factors are not closely tied to Puget Sound. In Washington, critical habitat was designated for green sturgeon along the outer coast, the Strait of Juan de Fuca, and the southern portions of the San Juan Islands. No critical habitat exists in Puget Sound proper (NMFS 2009a). There is currently no recovery plan for green sturgeon.

h. Southern Resident Killer Whale

Killer whales (*Orcinus orca*) are one of the most widely distributed marine mammals, found in all parts of the world's oceans. They are most abundant in colder waters including Antarctica, the North Atlantic, and Pacific Oceans. Southern Resident killer whales are one of four identified populations of killer whales in the North Pacific and the only known resident population to occur in the U.S. Southern residents are comprised of three pods: J, K, and L pods. The Southern Residents are considered one "stock" under the Marine Mammal Protection Act (MMPA) and one "distinct population segment" (therefore "species") under the ESA. The Southern Resident killer whale population is currently estimated at about 80 whales, a decline from its estimated historical level of about 200 during the late 1800s. Due to its small population size NMFS listed this segment of the population as endangered under the ESA in 2005 (NMFS 2005b) and designated critical habitat in 2006 (NMFS 2006b). A final recovery plan for the Southern Resident killer whale was published on January 24, 2008 (NMFS 2008).

Killer whales dependence on nearshore ecosystems can be tied to the importance of Chinook salmon in their diets. Chinook are a key prey item for resident killer whales (Ford *et al.*, 1998). Researchers in coastal British Columbia observed that 72.2% of the 396 salmon taken by killer whales were Chinook, despite the much higher abundance of the other species (Ford and Ellis 2005). Bioaccumulation of contaminants from prey resources originating from industrial areas has been identified as an on-going threat to killer whale survival (Ross *et al.*, 2000; Ross *et al.*, 2004).

i. Humpback Whale

The humpback whale (*Megaptera novaeangliae*) was globally listed as endangered in 1970 under the Endangered Species Conservation Act of 1969, the precursor to the ESA. In April 2015, NMFS completed a comprehensive status review and proposed revisions to the listing

(NMFS 2015). The currently single population would be divided into 14 DPS and listing status revised accordingly. The proposed western North Pacific DPS would be classified as threatened under the ESA. The public comment period has closed and NMFS has not yet issued a final rule. Until a final rule is issued the current status of humpback whale as ESA-listed endangered remains effective.

The humpback whale is at best an infrequent transient of inland Puget Sound waters, more commonly observed along the outer Washington coast (Calambokidis and Steiger 1990). USACE has determined that the PSNERP project will have no effect on humpback whales.

j. Marbled Murrelet

Marbled murrelet (*Brachyramphus marmoratus*) is a small marine diving bird that occurs from southern California to Alaska. Few data are available to interpret trends in population; however, there was an estimated 51% decline in north Puget Sound between 1978 and 2003 (Huff *et al.*, 2006). Recent trends indicate a continued steady decline of marbled murrelets, with a decrease in population of 7.9% from 2000 to 2009 in Puget Sound and the Strait of Juan de Fuca (USFWS 2009). Threats include habitat loss from timber harvest in their terrestrial environment, and harmful algal blooms, declining prey availability (forage fish), and catastrophic events such as oil spills in their marine environment. Due to rapid declines in population and on-going threats to their continued existence marbled murrelet were ESA-listed as threatened in 1992 (USFWS 1992).

Murrelets are common winter residents in northern portions of Puget Sound. Forage habitat is deeper water in entrance channels of rocky shores, estuaries, and protected bays (Angell and Balcomb 1982). Common prey items are forage fish like sand lance, smelt, and herring (USFWS 1997). Critical habitat includes upland forested stands used for nesting but does not include marine water used for foraging.

A Federal Recovery Plan for Marbled Murrelet was completed in 1997. The plan focuses on the protection of habitat in the terrestrial environment and acknowledges the need to do so in the marine environment. In addition it discusses reduction of mortality from the net fisheries, minimizing the occurrence of oil spills, implementing silviculture techniques to accelerate habitat development, and the need for research and monitoring (USFWS 1997).

k. Golden Paintbrush

Golden paintbrush (*Castilleja levisecta*) historically occurred at many sites in Puget Sound, British Columbia, and as far south as the Willamette Valley in Oregon. Its extirpation from the majority of these sites, including all of Oregon, led to its ESA listing as threatened (USFWS 1997). The majority of golden paintbrush current distribution is associated with remnant prairie ecosystems and reintroduction sites. While there are some remaining populations in the San Juan Islands and on Whidbey Island it is limited to upland balds and grasslands and is not prevalent in coastal areas. USACE has determined that the PSNERP project will have no effect on golden paintbrush.

2. State-Listed Species

According to a query of the WDFW's Priority Habitat and Species database conducted in December 2015 (Mitchell pers. comm.) the following Washington State sensitive species may occur within the vicinity of the area of projects proposed in the APA/RP:

Table 1: State sensitive species in project area.

Common Name	Occurrence Type	Occnrrence Class	State Status	Project Name
Bald eagle	Nest	Breeding	Sensitive	Nooksack River Delta
Great egret	Biotic detection	Regular individual	Monitored	Nooksack River Delta
Harbor seal	Haulout	NA	Monitored	Duckabush River Estuary
Harbor seal	Haulout	NA	Monitored	Nooksack River Delta
Western toad	Biotic detection	NA	Candidate	Duckabush River Estuary
Western toad	Biotic detection	NA	Candidate	North Fork Skagit River Delta
American white pelican	Concentration	Unknown	Endangered	Nooksack River Delta
Bald eagle	Concentration	Unknown	Sensitive	Nooksack River Delta

3. Other Salmonid Resources

According to a query of the Statewide Washington Integrated Distribution database conducted in December 2015 (Mitchell pers. comm.) the following salmonid species and runs may utilize watersheds of the projects proposed in the APA/RP:

Table 2: Salmonid species in project area.

Species/Run	Distribution Type	Use Type	Project Name
Coho	Documented	Presence	Duckabush River Estuary
Coho	Documented	Spawning	Duckabush River Estuary
Dolly Varden/ Bull Trout	Documented	Presence	Duckabush River Estuary
Fall Chinook	Documented	Presence	Duckabush River Estuary
Fall Chinook	Documented	Rearing	Duckabush River Estuary
Fall Chum	Documented	Rearing	Duckabush River Estuary
Pink Odd Year	Documented	Presence	Duckabush River Estuary

Pink Odd Year	Documented	Spawning	Duckabush River Estuary
Rainbow Trout	Documented	Presence	Duckabush River Estuary
Resident Coastal Cutthroat	Documented	Presence	Duckabush River Estuary
Resident Coastal Cutthroat	Presumed	Presence	Duckabush River Estuary
Summer Chum	Documented	Presence	Duckabush River Estuary
Summer Steelhead	Presumed	Presence	Duckabush River Estuary
Winter Steelhead	Documented	Presence	Duckabush River Estuary
Coho	Documented	Presence	Nooksack River Delta
Coho	Documented	Rearing	Nooksack River Delta
Coho	Modeled	Presence	Nooksack River Delta
Coho	Presumed	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Documented	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Documented	Rearing	Nooksack River Delta
Dolly Varden/ Bull Trout	Modeled	Presence	Nooksack River Delta
Dolly Varden/ Bull Trout	Presumed	Presence	Nooksack River Delta
Fall Chinook	Documented	Presence	Nooksack River Delta
Fall Chinook	Documented	Rearing	Nooksack River Delta
Fall Chinook	Modeled	Presence	Nooksack River Delta
Fall Chinook	Presumed	Presence	Nooksack River Delta
Fall Chum	Documented	Presence	Nooksack River Delta
Fall Chum	Modeled	Presence	Nooksack River Delta
Pink Odd Year	Documented	Presence	Nooksack River Delta
Rainbow Trout	Documented	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Documented	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Modeled	Presence	Nooksack River Delta
Resident Coastal Cutthroat	Presumed	Presence	Nooksack River Delta
Sockeye	Documented	Presence	Nooksack River Delta
Sockeye	Documented	Rearing	Nooksack River Delta
Spring Chinook	Documented	Presence	Nooksack River Delta
Summer Steelhead	Documented	Presence	Nooksack River Delta
Winter Steelhead	Documented	Presence	Nooksack River Delta
Winter Steelhead	Modeled	Presence	Nooksack River Delta
Coho	Documented	Presence	N. Fork Skagit River Delta
Coho	Documented	Rearing	N. Fork Skagit River Delta

Coho	Modeled	Presence	N. Fork Skagit River Delta
Dolly Varden/ Bull Trout	Documented	Rearing	N. Fork Skagit River Delta
Fall Chinook	Documented	Presence	N. Fork Skagit River Delta
Fall Chinook	Documented	Rearing	N. Fork Skagit River Delta
Fall Chinook	Modeled	Presence	N. Fork Skagit River Delta
Fall Chum	Documented	Presence	N. Fork Skagit River Delta
Fall Chum	Modeled	Presence	N. Fork Skagit River Delta
Kokanee	Documented	Presence	N. Fork Skagit River Delta
Pink Odd Year	Documented	Presence	N. Fork Skagit River Delta
Pink Odd Year	Modeled	Presence	N. Fork Skagit River Delta
Rainbow Trout	Documented	Presence	N. Fork Skagit River Delta
Resident Coastal Cutthroat	Documented	Presence	N. Fork Skagit River Delta
Sockeye	Documented	Presence	N. Fork Skagit River Delta
Spring Chinook	Documented	Presence	N. Fork Skagit River Delta
Summer Chinook	Documented	Presence	N. Fork Skagit River Delta
Summer Steelhead	Documented	Presence	N. Fork Skagit River Delta
Winter Steelhead	Documented	Presence	N. Fork Skagit River Delta
Winter Steelhead	Modeled	Presence	N. Fork Skagit River Delta

Many of the salmonid fish species which may occur with the project area are in decline due to loss or degradation of habitat. This includes species in Table 2 that are not listed under the ESA and discussed in Section II.C.1. Between 1992 and 2002 the Salmon and Steelhead Stock Inventory, used to compare trends in salmon stocks within Puget Sound, documented a 33% increase in the number of salmon stocks that were listed as depressed or critical (WDFW 1993 and 2002). While habitat protection and restoration actions are on-going, it is likely that populations of anadromous fish will continue to decline due to alterations in rearing and spawning habitat by armoring, filling, and diking of the shoreline, and upper watershed development. The impacts of climate change will likely exacerbate degraded habitat conditions in nearshore areas and may affect populations of anadromous salmonids. For example an 18- to 32-inch sea-level change in the Skagit Delta may reduce the rearing capacity in marshes for juvenile Chinook salmon by an estimated 211,000 and 530,000 fish respectively (Hood 2005). If regional salmon recovery is successful losses may be slowed and eventually reversed. However other factors could influence population trends of salmonids including harvest, environmental contaminants, oceanic conditions, and other aspects of climate change including increased water temperature and changes in stream flows.

IV. EVALUATION METHODOLOGY

There are no known established models or alternative methodologies that can adequately represent and consider the complexities and dynamics of the physical and biological processes interacting in the study area that affect fish, wildlife, and their habitat. Thus, best professional judgment and available science were used to evaluate benefits and impacts to fish and wildlife resources associated with implementation of the proposed PSNERP project. Service staff provided technical assistance to USACE and WDFW throughout the 10-plus years of active work of the PDT. This included representation in both interagency technical (i.e. Nearshore Science Team, Implementation Team) and policy (i.e. Steering Committee) groups convened to advise PSNERP. This GI has produced 24 peer reviewed technical reports that document study methods, analytical results, and ecosystem restoration approach. The Service also reviewed numerous studies conducted in the watershed and the study area by USACE and others investigating and documenting fauna, watershed processes, and sources of Puget Sound nearshore ecosystem degradation.

V. FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

To support analysis of without project conditions for the GI, the PDT commissioned a future risk assessment study. Future population estimates associated with a medium regional growth rate provided by the Washington State Office of Financial Management were used to extrapolate a projection of a regional population growing from nearly 4 million residents today to 9.1 million residents by 2065. This increase in population was used in a land development model to forecast changes in land use (Bolte and Vache 2010). With increasing population driving additional development many portions of the Sound are expected to encounter further degradation of nearshore ecosystem processes well beyond current conditions. This analysis suggests that large portions of southern and central Puget Sound will fall into a category of highly degraded (Schlenger *et al.*, 2011b). Without restoration, existing and future increases in shoreline stressors will contribute to further decline in nearshore habitat quantity, quality, and connectivity. The expanded footprint of degraded areas, combined with climate change and sea-level change, will further imperil the ecosystems that support diverse biological communities that inhabit or otherwise depend on Puget Sound.

Forecasts of future conditions suggest that without significant ecosystem restoration at-risk species may become further imperiled. Sea-level change is likely to cause substantial loss of surf smelt spawning habitat on beaches with armored shorelines because armoring prevents beach migration inland. (Griggs *et al.*, 1994). Reduction in spawning habitat may further depress stocks of surf smelt and other forage fish that rely on beaches. Anadromous fish species, already in decline due to habitat loss, will likely face increased risk of extirpation in highly impacted watersheds. Sea-level change will reduce availability of delta rearing habitats in locations where dikes, roads, and armoring prevent landward migration. Impacts to forage fish and juvenile salmonids will affect birds and mammals that utilize these prey resources. Statistically significant population declines have already been observed in many nearshore dependent bird species including red-throated loon, numerous grebe species, canvasback, scaup, black scoter, common goldeneye, ruddy duck, Bonaparte's gull, glaucous-winged gull, common murre, and marbled murrelet (Bower 2009).

VI. ALTERNATIVES CONSIDERED

A. Formulation of Alternatives

The October 2014 Draft Feasibility Report and Environmental Impact Statement (FR/EIS) evaluated 18 projects for potential implementation by PSNERP and identified a PA of constructing 11 of these projects (Table 3, Figure 3) (USACE 2014). During a subsequent feasibility study completion strategy workshop attended by representatives of the Office of the Assistant Secretary of the Army, Corps Headquarters, Northwestern Division, Seattle District, and the non-federal sponsor (WDFW), alternatives were modified and a revised PA developed. Workshop participants revisited the complete list of 36 projects from which the October 2014 alternatives were derived. During this "vertical team" workshop, the list of projects identified by the GI was organized into five categories based on their status of completion by other programs, suitability for implementation under existing Corps of Engineers construction authorities, or eligibility for completion through the GI process. CAP eligible projects were distinguished by their suitability for either §206 or §1135 authorities. This category of GI eligible projects was further divided into those projects for which PSNERP provides a sufficient level of detail for immediate authorization, and those projects for which additional data collection and analysis will be required prior to authorization (Table 4). USACE now defines this delineation of the 36 PSNERP projects into one of four potential construction authorities (or completion by others) as a "tiered approach" to implementation.

The outcome of this workshop is outlined in a memorandum from the USACE Director of Civil Works (Headquarters) to the Commander of the Northwest Division (Portland) (USACE 2015). This includes the outcome of the workshop in categorizing restoration projects for implementation under USACE authorities. Most notably, the memo identifies three projects which met the definition of Category 4 (Table 4) and could therefore be advanced by USACE for implementation as an outcome of the GI.

Based on this guidance the potential projects have been reformulated to derive a new alternative. Alternative 4 is the current Agency Preferred Alternative/Recommend Plan for the purposes of the NEPA analysis documented in the FR/EIS (Table 3).

B. Additional Actions of the Tiered Approach

In addition to the three sites now proposed as the APA/RP, nine sites were determined to be potentially eligible for completion through a Corps GI authority. However these projects currently lack sufficient engineering design and other detail sufficient for authorization at this time. Therefore, in addition to the three sites proposed for authorization, USACE has identified nine sites to be the subject of additional future studies prior to a potential request for authorization:

- Dugualla Bay
- Everett Marshland
- Telegraph Slough

- Chambers Bay
- Big Beef Creek Estuary
- Tahuya River Estuary
- Lilliwaup Estuary Restoration
- Big Quilcene River
- Snohomish Estuary

In addition to completion of the three projects included in the APA/RP and potential future authorization of nine projects listed above, USACE and WDFW propose to pursue implementation of up to 12 additional projects outside of the GI process using other programs and authorities, including CAPs. Sites that could be completed through existing authorities include:

Projects that can be implemented under the WRDA 2000 §544 Puget Sound and Adjacent Waters authority.

- Spencer Island
- Quilceda Estuary
- Twanoh Beach
- Twin Rivers

Projects that can be implemented under WRDA §206 or §1135 CAP.

- Deepwater Slough
- Livingston Bay
- Harper Estuary
- Budd Inlet Beach
- Everett Riverfront Wetlands
- Chuckanut Estuary
- Sequalitchew Creek
- McGlinn Island

Taken together, the three projects proposed for immediate implementation, nines sites identified for additional study and potential future authorization, and 12 sites that can be implemented utilizing existing authorities and programs comprise the tiered approach to nearshore ecosystem restoration now envisioned by USACE and WDFW.

Table 3: Revised Alternatives and Associated Project Sites.

Alternative ID - Name	Project Site Names
Alternative 1 - No Action	
Alternative 2 - 11 Sites	
	Deepwater Slough
	Everett Marshland
	Milltown Island
	Nooksack River Delta
	North Fork Skagit River Delta
	Spencer Island
	Telegraph Slough
	Deer Harbor Estuary
	Dugualla Bay
	Livingston Bay
	Beaconsfield Feeder Bluff
Alternative 3 - 18 sites	
	Deepwater Slough
	Duckabush River Estuary
	Everett Marshland
	Milltown Island
	Nooksack River Delta
	North Fork Skagit River Delta
	Spencer Island
	Telegraph Slough
	Deer Harbor Estuary
	Harper Estuary
	Snow Creek and Salmon Creek Estuary
	Tahuya River Estuary
	Big Beef Creek Estuary
	Dugualla Bay
	Livingston Bay
	Point Whitney Lagoon
	Beaconsfield Feeder Bluff
	Budd Inlet Beach
Alternative 4 - 3 sites (preferred alternative)	
	North Fork Skagit
	Nooksack River Delta
	Duckabush River Estuary

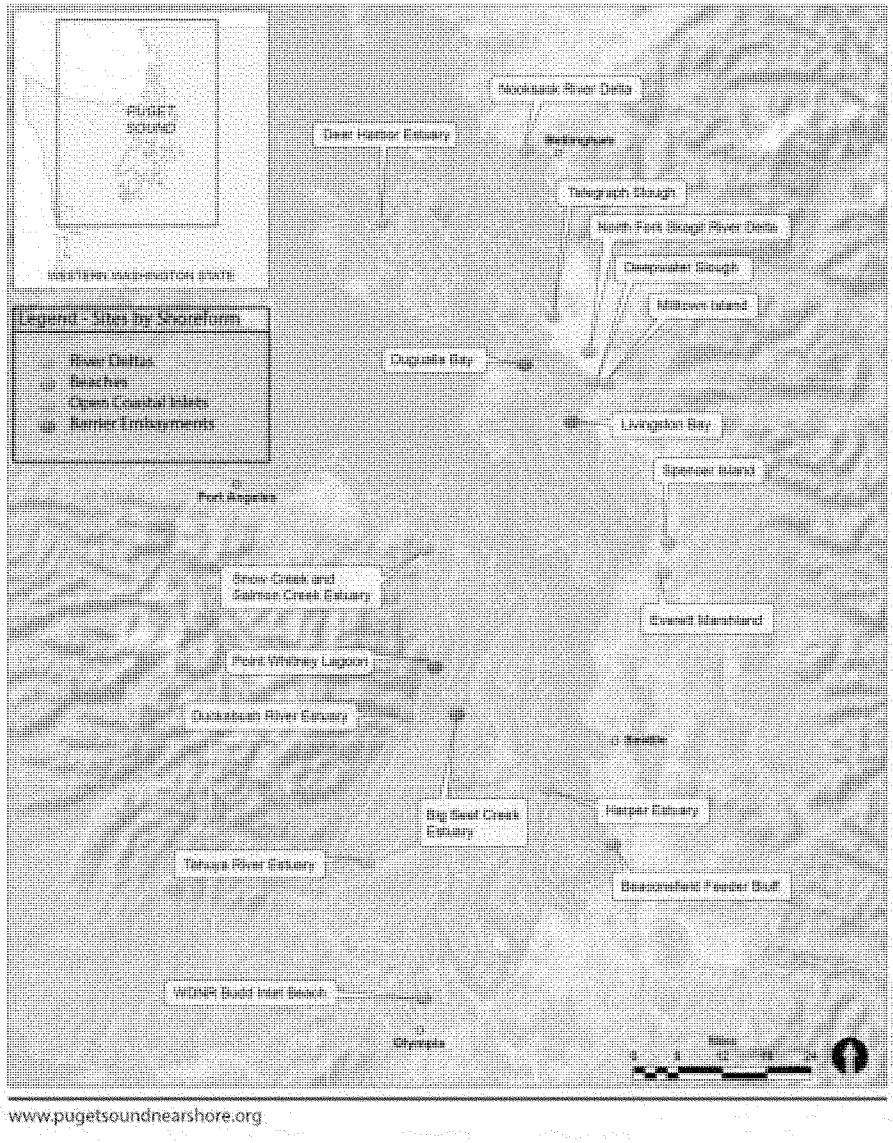

Figure 3: PSNERP Potential Project Sites

Table 4: Categorization of 36 PSNERP Projects by Tier.

Tier	Category	Project Site Names
1	***Projects in which other agencies are moving forward or have implemented restoration***	
		Milltown Island
		Point Whitney Lagoon
		Beaconsfield Feeder Bluff
		Kilisut Harbor/Oak Bay Reconnection
		Deschutes River Estuary
		Hamma Hamma Estuary
		Snow Creek and Salmon Creek Estuary
		Johns Creek Estuary
		Deer Harbor
		Mission Creek
		Smith Island
		Washington Harbor
2	***Projects that can be implemented under WRDA §544 Puget Sound and Adjacent Waters***	
		Spencer Island
		Quilceda Estuary
		Twanoh Beach
		Twin Rivers
3	***Projects that can be implemented under WRDA §206 or §1135 CAPs***	
		Deepwater Slough
		Livingston Bay
		Harper Estuary
		Budd Inlet Beach
		Everett Riverfront Wetlands
		Chuckanut Estuary
		Sequalitchew Creek
		McGlinn Island
4	***Projects that fall within the GI program and have the level of detail to move forward***	
		North Fork Skagit River Delta
		Nooksack River Delta
		Duckabush River Estuary
5	***Projects that fall within the GI program but require additional analysis***	
		Dugualla Bay
		Everett Marshland
		Telegraph Slough
		Chambers Bay
		Big Beef Creek Estuary
		Tahuya River Estuary
		Lilliwaup Estuary
		Big Quilcene River
		Snohomish Estuary

C. Agency Preferred Alternative / Recommended Plan

The revised APA/RP that USACE and WDFW now propose to advance for PSNERP includes three projects that have sufficient level of analysis to move forward for implementation at this time. These three sites are the focus and outcome of the NEPA process, and represent the primary scope of analysis for the Service's FWCA §2(b) Report:

- North Fork Skagit River Delta
- Nooksack River Delta
- Duckabush River Estuary

1. North Fork Skagit River Delta

The North Fork Skagit River empties into Skagit Bay south (downstream) of La Conner, Washington. The proposed action is located between the former Dry Slough inlet and the western levee system's end near Rawlins Road. Extensive diking of the North Fork caused substantial loss of tidal wetlands and associated tidal channels. River levees reduced the floodplain area and constrained the river channel. In the last century the Skagit Basin has lost approximately 80 percent of historic estuarine delta habitat, including a loss of 35 percent of estuarine mixing habitat, 98 percent of low salinity transitional habitat, and 89 percent of its freshwater tidal habitat (Simenstad *et al.,* 2011).

The Skagit River watershed is critically important to all five species of Pacific salmon as well as steelhead and sea-run cutthroat. This importance is due in large part to the productivity of large wilderness areas in the upper watershed upstream from the diked and developed floodplain (SWC 2002). The extensive remnant aquatic habitat in the delta is also an important contributing factor to salmonid productivity and significant loss of tidal wetlands is a limiting factor for Chinook recovery (SWC 2005). The Skagit watershed supports 30 percent of all anadromous fish in Puget Sound and the largest populations of pink and chum in the contiguous United States (North Cascades Institute 2002, Smith no date). The Skagit River and its tributaries also host the largest populations of ESA-listed bull trout, steelhead, and wild Chinook in the Puget Sound Basin (USFWS 2004, Smith no date).

Declining salmon runs in the Skagit and elsewhere contribute to a cascading series of ecosystem impacts. Fewer returns of naturally spawning fish leads to declining marine nutrient input to riverine ecosystems as well as less food availability for bald eagles, bears, and other species that scavenge carcasses. Numerous species of fish, birds, and mammals – including people – rely upon an abundance of salmon. Declines of Chinook salmon in marine environments of Puget Sound have been identified as a limiting factor for the ESA-listed southern resident killer whales. Additionally, the depressed levels of salmon populations have all but eliminated the once great commercial fishing industry of western Washington and severely reduced sport fishing opportunities. These declines have widespread impact on regional Native American tribes with cultures and economies dependent on salmon (USACE 2016).

The Skagit River Delta area is also a critical waterfowl wintering area due to the mild climate and available habitats including marshes, intertidal flats, and adjacent agricultural fields. It is an important stopping point for migratory birds along the Pacific Flyway including trumpeter swans

and Wrangell Island snow geese. At least 180 species of birds have been documented in the project area including raptors, waterfowl, shorebirds, game birds, and songbirds (WDFW 2006). Wading birds, such as great blue heron, utilize the estuary areas year round. Shorebirds use flooded agricultural fields and estuaries primarily for feeding station during their long migration and as over-wintering habitat. Dunlin and black bellied plover winter in the Skagit delta. Although a large number and variety of birds use the area this broad delta could be substantially more productive in its restored condition with native plants and greater areas of distributary channels in the nearshore zone to support significantly greater populations of birds.

a. Key Design Elements

The restoration proposal lowers 13,000 linear feet of levee along the North Fork Skagit River south bank. Work will remove several structures and construct a levee along Rawlins Road as well as lower 3,140 feet of levee along the north bank. Existing topography provides flood risk management without a levee on the river's north side. Breaches in the lowered levees and excavated channels allow for water to access the newly restored floodplain restoring tidal hydrology to approximately 250 acres of historic tidal marsh habitat. Replanting lowered levees will restore a natural riparian corridor along the river (Figure 4). Total project costs are estimated at $102 million.

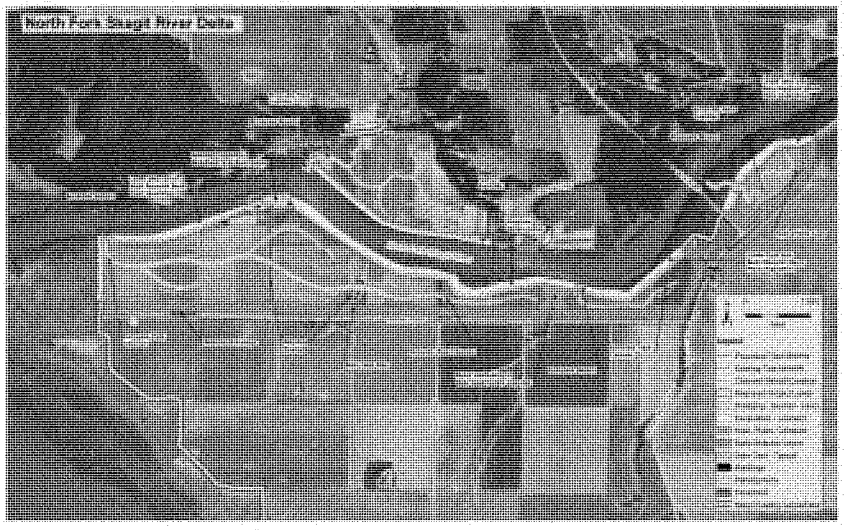

Figure 4: Key restoration design elements for North Fork Skagit River delta site.

2. Nooksack River Delta

The Nooksack is one of the largest contributing watersheds in Puget Sound and supports numerous salmonid stocks with relatively high abundance. The Nooksack River system supports nine species of salmonids represented by more than 20 distinct stocks that are separated by their run timing and spawning location. Three of these species are listed under the ESA: Puget Sound Chinook, Puget Sound steelhead, and Coastal/Puget Sound bull trout. The Nooksack River is one of five geographic areas considered essential for recovery of the Puget Sound Chinook ESU. Other anadromous salmonid species found in the Nooksack River include riverine sockeye, coho, even-year and odd-year pink, and chum salmon; summer and winter steelhead; and coastal cutthroat trout. Runs of all of these species have declined significantly from historic levels. In addition to being of critical importance for fishery resources the Nooksack River delta provides important habitat for migratory shorebirds of the Pacific Flyway, waterfowl, trumpeter swans, Canada geese, and the Wrangell Island snow geese.

The Nooksack River delta is located primarily on the Lummi Nation lands north of Bellingham, Washington. It includes nearly all of the Nooksack and Lummi River estuaries below Ferndale, Washington. The Nooksack and Lummi River flow paths have been modified since the mid-19th century beginning with active removal of large wood, draining, diking and levee construction. Today substantial surface water diversions, groundwater withdrawals, and drainage activities within the Nooksack River watershed impact the magnitude, timing and duration of delta surface water flows. The Nooksack floodplain has undergone a substantial loss of tidal freshwater and estuarine wetlands from an estimated 8,785 acres in 1888 to 3,211 acres remaining today, representing a 64% loss. This includes a 71% loss of vegetated tidal wetlands. More than half of the remaining acreage is disconnected from its natural hydrology by dikes, roads, and tidegates. The proposed restoration modifies levees, roads, and other hydrological barriers, restoring delta riverine and tidal flow, as well as sediment transport and delivery processes.

a. Key Design Elements

The restoration actions include partial levee removal along both Nooksack River banks. Restoration actions along the Lummi River includes levee setback and construction on North Red River Road. Approximately 12,000 linear feet of levees would be breached or removed, restoring 1,800 acres of tidal freshwater wetlands. Existing levels of flood protection for buildings, roads, and other infrastructure will be maintained by construction of new setback levees, often concurrent with existing arterial roads. Log jams installed on the Nooksack River would restore more natural channel morphology and enhance instream habitat availability. The Lummi River channel will be dredged and graded to reconnect it to Nooksack River flows and setback levees would be constructed. A water control structure at the historic divergence of Lummi and Nooksack River would replace the current dike which prevents freshwater from entering the Lummi River. Several roads on filled causeways would be replaced with widespan bridges to allow more tidal flow across the delta (Figure 5). This combination of numerous significant project features implemented at a large scale leads to a total project cost estimate of $260 million.

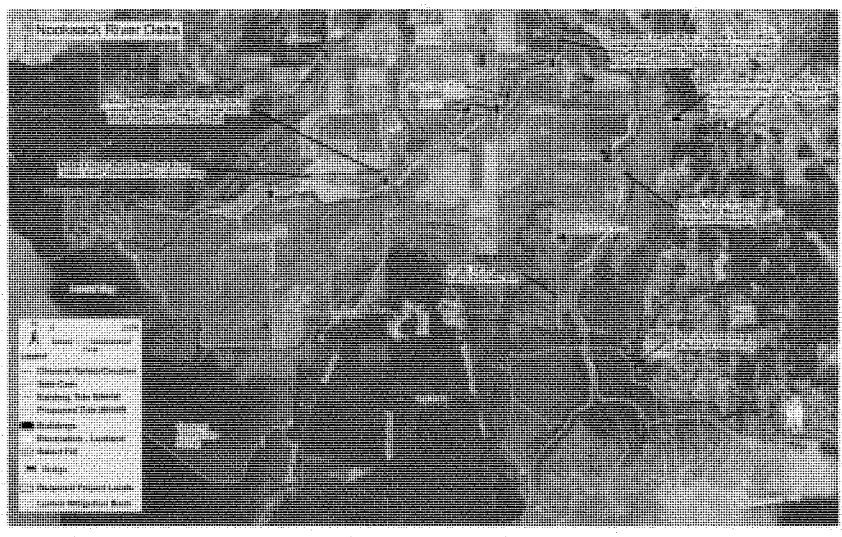

Figure 5: Key design elements for the Nooksack River delta site.

3. Duckabush River Estuary

The Duckabush River is one of several major river systems that drain the east slope of the Olympic Mountains to Hood Canal. The broad river delta fans out into Hood Canal on the south side of Black Point Peninsula. The Highway 101 causeway crosses the delta spanning the main channel and a historic distributary channel via bridges with box culverts. Levees along the main channel upstream of the causeway prevent river flows into historic distributary channels. This causeway limits tidal exchange and contributes to aggradation in tidal channels. These hydrologic constrictions along with fill within the estuary have led to decline in mudflats and salt marsh.

The Duckabush River supports four ESA-listed species of salmonids: Hood Canal summer chum, Puget Sound steelhead, Coastal/Puget Sound bull trout, and Puget Sound Chinook salmon. The wild Chinook run is nearly extirpated from this river. The Duckabush Estuary also supports important wildlife resources including trumpeter swans, bald eagles, and regionally significant concentrations of wintering waterfowl. Harbor seals haul out in this location throughout the year and pupping occurs in the winter. The extensive mud and gravel flats are productive shellfish beds. Salt marshes and eelgrass beds characterize the upper and lower intertidal and subtidal areas, respectively. Herring use this eelgrass for spawning.

a. Key Design Elements

Proposed restoration actions would restore natural hydrology to approximately 38 acres of the Duckabush River delta. Key features of the project include replacement of the Highway 101 causeway with a bridge of sufficient span to allow unconstrained riverine and tidal hydrology. This is the primary measure for this site as the Highway 101 causeway and two bridge structures are the key impediment to ecosystem process restoration at the site. Fill associated with Shorewood Road and other areas that impact floodplain wetlands would be removed and regraded. Filled distributary channels and sloughs would be excavated and large wood placed to reinitiate channel forming processes (Figure 6). Reinitiating natural water and sediment processes would also benefit downstream habitats allowing tidal flats and salt marsh habitats to accrete sediment and remain resilient in response to changing sea levels. Replacement of this 1,200 linear feet river crossing contributes significantly to the $63 million estimated total project cost.

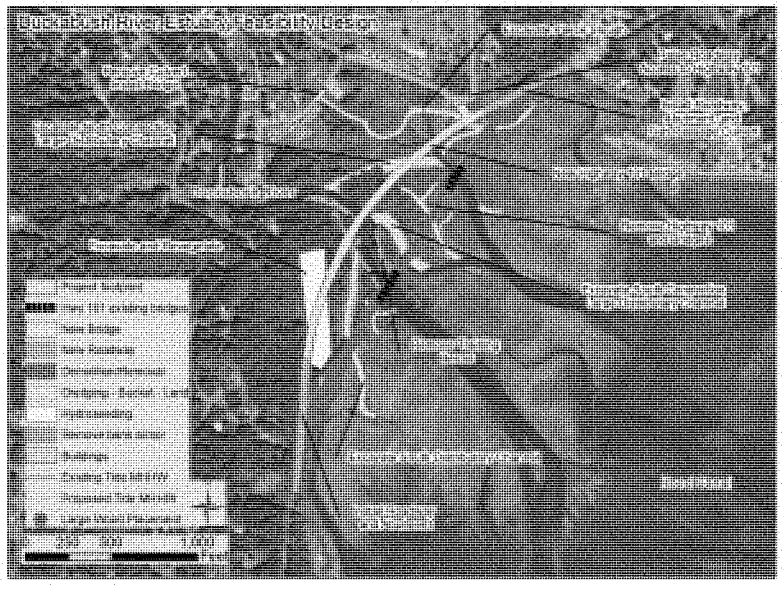

Figure 6: Key design elements for the Duckabush River Estuary site.

D. Other Alternatives

The other two action alternatives (Alternatives 2 and 3; see Table 3) include a greater number of projects for implementation under the PSNERP program. These alternatives were the subject of the 2014 DFR/EIS. Alternative 2 proposed the implementation of 11 restoration sites. The 2014

DFR/EIS identified this as the Preferred Alternative / Tentatively Selected Plan. Alternative 3 involved a larger program of 18 restoration sites (Figure 3). As discussed above in Section VI.A, during review of these alternatives by Corps Headquarters, Alternative 4 was formulated with the PDT (Seattle District and WDFW) and emerged as the Agency Preferred Alternative / Recommended Plan (APA/RP).

VII. PROJECT IMPACTS

A. Preferred Alternative / Recommended Plan

A full description and evaluation of project impacts is not possible since project designs for sites included in the APA/RP (and other action alternatives) are only at the conceptual stage of development. If authorized for implementation, future phases of the project would finalize project features and complete detailed engineering design. This will include additional discussions with affected landowners which may impact the footprint and scope of restoration actions.

In general there will be short-term negative impacts from construction of each action including diminished water quality (turbidity and suspended sediment), noise disturbance from construction machinery, airborne particulates from soil disturbance, and vegetation removal and disturbance associated with construction of temporary equipment access routes and conducting activities at each work site. These construction-related effects are common to many restoration activities and standard conservation measures and BMPs are generally followed to minimize the frequency, intensity, and duration of these impacts. For example, in designing and implementing Service-funded restoration projects, partners adhere to standard BMPs and conservation measures (CMs) outlined in a programmatic biological assessment/biological opinion (USFWS 2015). All of the PSNERP proposed restoration actions have analogs in this programmatic consultation document and it is anticipated that USACE BMPs/CMs would be similar to those outlined in this and other restoration guidance.

The goal of PSNERP is to restore ecosystem process to provide long-term benefits to fish and wildlife species from implementing the actions identified in the APA/RP. In all cases it is reasonable to expect that benefits will outweigh negative impacts. Potential beneficial and negative impacts of each proposed action are discussed below. A more thorough evaluation of effects of implementing the APA/RP will be possible as the project advances into the design stage.

1. North Fork Skagit River Delta

a. Ecosystem Restoration Benefits

Project benefits extend across an estimated 256 acres where daily tidal and seasonal/episodic flood flows would be restored (Figure 7). Removal of barriers to tidal and riverine hydrology reestablishes important habitat-forming ecosystem processes including sediment transport, freshwater input, tidal exchange, channel migration, marsh accretion, overbank deposition, and natural levee formation. Ecosystem benefits include the restoration of highly productive tidal

wetland habitats that support diverse fish and wildlife resources and provide connectivity between terrestrial and nearshore ecosystems. River delta ecosystems provide valuable rearing habitat for numerous species of juvenile salmonids, increasing survival and supporting recovery of Puget Sound populations, including threatened Chinook salmon and bull trout.

This project will also contribute to increases in shorebird foraging and resting habitats associated with tidal flats benefitting dunlin, great blue heron, and other wading/probing birds. Restoration of sediment input will promote marsh accretion downstream from the project site improving resilience of the estuary to effects of sea level change. Water quality will be improved by increasing floodplain retention time and flow through vegetated wetlands.

The significance of this project is underscored by its identification in the Skagit River watershed chapter of the Puget Sound Chinook Salmon Recovery Plan (Shared Strategy 2007). To date, most Skagit estuary restoration projects have been implemented along the South Fork Skagit River. This project would provide a significant increase in estuarine habitat on the lower North Fork Skagit River where developed and agricultural lands behind constructed flood control levees limit available habitat and restoration opportunities.

The separately authorized and implemented Skagit River GI Feasibility Study is recommending flood risk management actions well upstream of the North Fork Skagit River project site. Ecosystem restoration actions proposed as part of the PSNERP recommended plan are independent from the Skagit flood risk management recommendations and are described as complementary to those separately proposed actions (USACE 2014).

b. Potential Adverse Impacts

Common to other sites where extensive excavation is proposed to remove or setback levees and restore filled tidal channels, this project would have temporary adverse impacts on aquatic habitats and organisms. Negative impacts include increased turbidity from excavation and dredging. Consistent with permit conditions and conservation measures construction would be limited to designated annual work windows when fish are less likely to be present and during low tides. Depending on specific construction activities at this site it may be necessary to install cofferdams or other water isolation structures to separate in-water construction activities from areas where fish or other wildlife sensitive to turbidity are present. Programmatic consultation documents for restoration projects identify these and other BMPs to ensure minimization of short term impacts. It is reasonable to anticipate that site specific BMPs will be developed following resolution of engineering design details, construction methods, sequencing of actions and project schedule.

There is a report indicating that a historic landfill or dump may exist within the project footprint. However there are no known active cleanup sites within the project footprint and no site records listed on the WDOE clean-up site database. Service (USFWS 2011) preliminary contaminant screening did not confirm this report. Additional site assessments are planned to determine if unresolvable contaminant issues exist within the project area. If contaminants are found to be present, those areas would be excluded from USACE restoration activities.

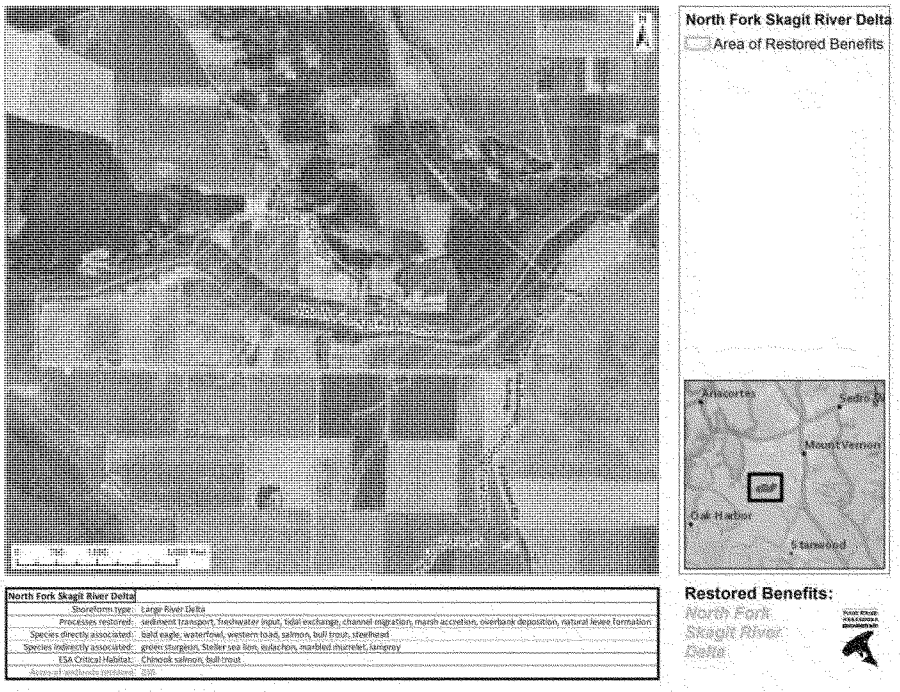

Figure 7: Area of Restored Benefits at North Fork Skagit River Delta site (from USACE 2014).

2. Nooksack River Delta

a. Ecosystem Restoration Benefits

As described above in VI.B.2 the Nooksack River delta project includes numerous actions across a large portion of the lower two miles of the Nooksack and Lummi Rivers. Actions planned to increase flood plain area and reconnect tidal and riverine flows would restore 1,807 acres of scarce tidal freshwater wetlands. Removal of levees and other anthropogenic stressors will reinitiate sediment transport, freshwater input, tidal exchange, channel migration, marsh accretion, and longshore sediment transport processes. Resulting habitat benefits Chinook salmon and bull trout as well as peregrine falcon, bald eagle, shorebirds, waterfowl, invertebrates, forage fish, and eelgrass. Proposed restoration complements, but does not depend on, the proposed Lummi Nation Wetland and Habitat Bank project downstream and adjacent to this site (Lummi Nation 2008).

This project will restore a very large area of the river delta, providing additional rearing habitat for juvenile salmonids, increasing survival and supporting Puget Sound population recovery.

Re-established intertidal and shallow subtidal areas would facilitate kelp and eelgrass growth, increasing nearshore productivity for fish, birds and other marine species. This project would restore important landscape features, including connectivity between nearshore and adjacent uplands, and shoreline area, length, and complexity. Benefits include improved resiliency to potential climate change impacts, including rising sea levels and increased frequency of storms and floods.

Significant in scale as a stand-alone action, this project also builds on the Lummi Nation's existing and planned mitigation bank projects that similarly restore delta ecosystem processes and habitats. These projects are also central to Whatcom County's comprehensive approach to managing flooding and restoring estuary habitat in the lower Nooksack River. Restoration actions are aligned with the Puget Sound Chinook Salmon Recovery Plan. Implementation will provide 25 percent of Puget Sound Action Agenda's 2020 estuarine habitat recovery goal in this single project (PSP 2014).

b. Potential Adverse Impacts

Extensive levee setback and removal actions are proposed for this site. Similar to effects described for North Fork Skagit short-term impacts from increased turbidity can be expected from excavation work that would degrade water quality. This project also involves the replacement of bridges on the Lummi River and Tennant Creek (tributary to Nooksack). Bridge construction often involves various construction methods including use of tugboats, drilling, rock placement, and pile driving. Sound levels associated with these activities would temporarily increase during construction with some noise-generating activity potentially exceeding thresholds that are harmful to fish and wildlife. Estimates of sound levels should be calculated once project implementation details have been established and compared to data available on aquatic species' hearing and the regulated sound threshold under the ESA and the MMPA. Each method of construction that produces harmful underwater noise should be mitigated through physical means such as bubble curtains and sound dampening mats or through conservation measures including wildlife monitoring. Preliminary site construction plans avoid pile driving, the most deleterious of potential noise generating actions. Bridge supports are proposed as drilled shafts and poured concrete piers instead of compression driven steel piles.

The Lummi Nation has expressed concerns about the potential for reestablishing Lummi River flows to adversely affect tribal shellfish operations. Tribal concerns involve the possible increased delivery of pollutants from the Nooksack River to Lummi Bay. Restoration of Lummi River flows will require assessment of upstream water quality and modeling of downstream impacts to receiving waters. USACE (2014) acknowledges the need for further water quality analyses during future design phases to better understand potential impacts to shellfish beds.

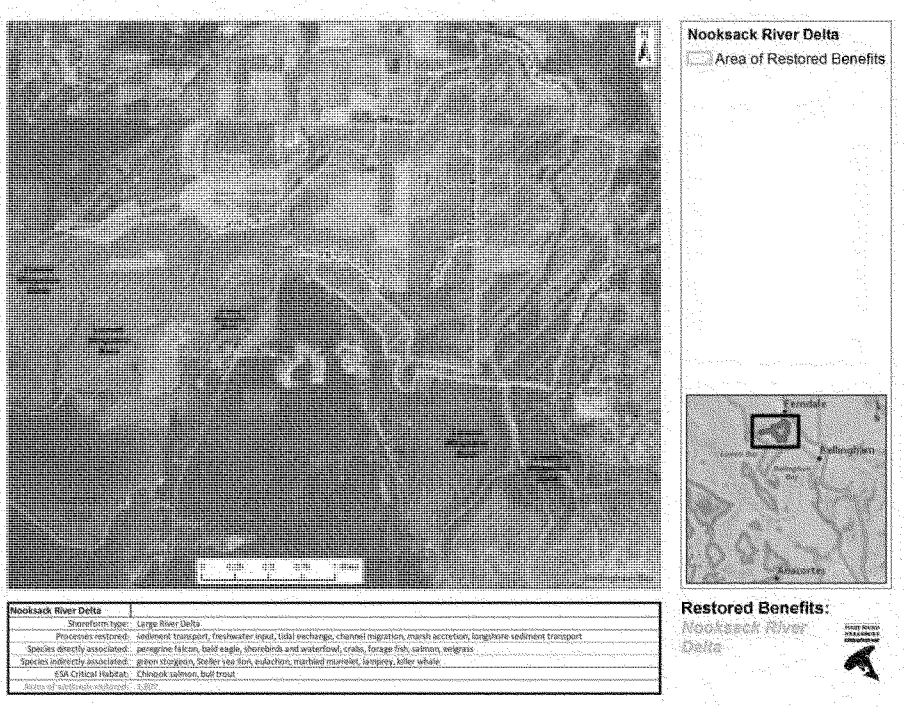

Figure 8: Area of Restored Benefits at Nooksack River Delta site (from USACE 2014).

3. Duckabush River Estuary

a. Ecosystem Restoration Benefits

Restoration at this site provides benefits to ESA listed Chinook, Hood Canal summer chum, steelhead, and bull trout. The project provides direct benefits to harbor seals, bald eagles, waterfowl, shellfish, and eelgrass habitat at the edge of the site. Duckabush estuary restoration provides an opportunity to reconnect floodplain and intertidal wetlands, improving tidal exchange, sediment transport, and estuary development. Realignment of roads and bridges will restore tidal inundation and hydrology. Reconnection of distributary channels will promote greater diversity and resiliency of delta wetland habitats.

In addition to these habitat benefits the project may also improve intertidal and shallow subtidal areas that support important recreational and tribal shellfish resources. Oysters, clams, and mussels are harvested on lands managed by WDFW and others for this purpose. Channelization of the Duckabush River and the hydraulic constraints of the current bridge-opening direct sediment to a relatively small portion of the delta leaving large areas of tidal flats disconnected from sediment supplies and vulnerable to loss from erosion and sea level change.

b. Potential Adverse Impacts

Bridge replacement is a major construction element of this project. Short-term impacts to turbidity can be expected following fill removal and channel reconstruction. In-water work is required for bridge replacement. However, pile driving is not proposed. Existing piles will be removed and test holes will used to assess substrate stability. Neither of these activities creates noise levels commensurate with pile driving. New bridge supports will be drilled and cast in place concrete piers to minimize noise impacts to aquatic species.

While general concerns discussed for the previous projects apply at this site as well, at this phase of design development, no site-specific potential adverse impacts to the biological environment have been identified.

The Duckabush River Bridge is listed on the National Register of Historic Places. Removal and replacement of this historic resource will require compliance with Section 106 of the NHPA including mitigation of impacts. USACE indicates that they are currently working on a Programmatic Agreement with the Washington State Historic Preservation Office, the Advisory Council of Historic Preservation, interested Tribes, and members of the public to address NHPA compliance for this site and other potentially affected cultural and historic resources.

B. Other Plans

The No Action Alternative (Alternative 1) would allow causes and consequences of nearshore ecosystem degradation to persist and worsen. Section V provides a discussion of the likely implications to fish and wildlife resources in the study area if proposed restoration actions are not implemented.

Other action alternatives anticipate implementation of substantially more restoration than that proposed by the agency preferred alternative / recommended plan. Alternative 2 would advance 11 sites for construction and was the initial APA/RP. Alternative 3 assessed environmental outcomes of restoration at 18 sites across Puget Sound including the 3 proposed under the current APA/RP.

Alternative 2 would restore 5,348 acres of nearshore habitat. This compares to 5,517 acres for Alternative 3 and 2,101 acres restored for Alternative 4. Alternatives 2 and 3 would more completely address project objectives by including one or more beach restoration sites involving armor removal. These alternatives also include sites where tidal hydrology is restored to coastal embayments, "pocket estuary" features not associated with one of the 16 major river deltas in the study area. Alternative 4 does not include beach or embayment sites and focuses largely on river delta restoration. The 11 sites that comprise Alternative 2 have a total cost of approximately $1.06M; the Alternative 3 sites have a total cost of approximately $1.25M. For comparison, total costs of the APA/RP (Alternative 4) are approximately $0.45M.

VIII. EVALUATION OF ALTERNATIVES

Soundwide systematic analysis completed by the PSNERP PDT led to definition of six problem statements based on this scientific analysis. These problem statements provide a clear rationale for addressing the underlying causes of widespread nearshore ecosystem degradation and habitat loss. Large river deltas, smaller coastal embayments, and the bluff/beach systems that dominate the Puget Sound shorescape have all been widely impacted and are greatly diminished in quantity, quality, and connectivity relative to conditions in c.a. 1850. Numerous fish and wildlife resources rely upon these productive ecosystems that occupy the terrestrial/marine ecotone. Emblematic of the relationship between nearshore habitat loss and degradation are Pacific salmon species. While overfishing and upper watershed habitat impacts have contributed to the systematic decline in salmon production, estuarine wetland habitat loss which averages 55% in Puget Sound, is a significant limiting factor for species recovery. Declines in populations of marine birds and other species show similar correlations between nearshore habitat loss and observed population declines. These observations support the conclusion of a compelling need for significant, large-scale nearshore ecosystem restoration. The study area is clearly in need of restoration to improve habitat conditions for listed and non-listed fish and other aquatic species, and for general aquatic ecosystem health.

The no action alternative (Alternative 1) would allow causes and consequences of nearshore ecosystem degradation to persist and perhaps worsen. Failure to implement projects following the substantial investment USACE, WDFW, the Service, and other partners have made towards the success of PSNEP would represent a significant missed opportunity. Western Washington tribes have asserted that habitat restoration efforts are not keeping pace with on-going habitat loss in Puget Sound. Nearshore habitat loss is impeding salmon recovery efforts to the detriment of tribes who depend on treaty reserved fishing rights for economic and cultural sustenance (NWIFC 2011). Federal agencies, including USACE, have an obligation to contribute to Puget Sound recovery; implementation of projects through the GI and other authorities provides an opportunity to do so.

Although it provides less benefit than other action alternatives, Alternative 4 (APA/RP) would significantly contribute to Puget Sound recovery. Nooksack, Skagit, and Hood Canal are priority areas for recovery and Alternative 4 proposes important advances in these regions by implementing over 2,100 acres of nearshore restoration focused in river deltas. These projects will provide numerous ecosystem benefits and provide important habitat for fish and wildlife resources discussed above. Adverse environmental effects are minor in scale and duration compared to ecosystem benefits. Most adverse effects can be significantly minimized by implementing standard BMPs including timing construction activities for periods when fish and wildlife are less likely to be present.

Alternative 2, involving implementation of 11 restoration projects throughout the study area, would provide substantially greater ecosystem benefits than the APA/PR. Over 2 times as many acres of intertidal habitat would be restored, at a commensurate increase in project costs. While this alternative was originally identified as the Tentatively Selected Plan in the Draft FR/EIS, USACE is now advancing a tiered approach to the numerous projects evaluated by the GI and the request for immediate authorization of 3 sites represented in Alternative 4.

Alternative 3, even larger in scope and spatial scale and would advance 18 projects for construction. This alternative would accelerate Puget Sound recovery efforts delivering improvements in nearshore ecosystem conditions throughout the study area. The Service strongly endorses a USACE ecosystem restoration authority that would enable this comprehensive alternative. However this alternative did not meet USACE tests of cost effectiveness and was not carried forward due to significant increases in cost for the larger suite of restoration sites.

While not a formal alternative assessed through the USACE NEPA analysis, full implementation of the tiered approach would likely exceed the scope of ecosystem restoration of alternatives evaluated with as many as 24 projects diverse in size and features constructed throughout the entirety of the Puget Sound basin.

IX. RECOMMENDATIONS FOR FISH AND WILDLIFE CONSERVATION

The Service supports the APA/RP and is providing the following recommendations to minimize potentially adverse effects and maximize benefits to fish and wildlife resources associated with the proposed actions. Recommendations are divided into two tiers. Tier 1 recommendations are considered essential for minimizing potential negative impacts of the actions and ensuring that intended benefits are realized. Tier 2 recommendations are those that will enhance overall restoration effectiveness in the study area and provide additional benefits beyond those currently represented in the APA/RP.

A. Tier 1 Recommendations: Ensuring APA/RP Effectiveness

1. The Service recommends that USACE adhere to BMPs and conservation measures applicable to construction activities required to implement restoration projects. USACE should seek to avoid the need for variances and exceptions from practices that avoid or minimize adverse impacts to fish and wildlife resources.

2. The Service recommends that projects requiring replacement of highway and road bridges implement conceptual designs that avoid pile driving. Current plans specify that new bridge supports will be cast-in-place concrete piers to avoid noise impacts to aquatic species.

3. The Service recommends that riparian buffers installed by USACE restoration authorities and programs be consistent with NMFS guidelines for protection of salmon habitat functions. Projects that invest public resources in ecosystem restoration should conform to the highest standards of environmental protection.

4. The Service recommends that USACE and their partners exercise creativity and flexibility in working with landowners and other stakeholders in seeking to establish the maximum amount of ecosystem benefits from restoration projects. The Service understands that USACE and WDFW have a significant amount of work remaining to finalize project designs and construction plans. This will include negotiations with landowners and coordination with other interested parties to establish final project boundaries and the area of restored ecosystem benefits.

5. The Service recommends that USACE continue to coordinate closely with tribal governments and entities with interest in these projects. In addition to compliance with requirements for formal government-to-government coordination, we strongly advise continued informal coordination with tribal government agency staff and tribal leaders. Success of these projects will be greatly facilitated by integrating collaboration with western Washington tribes throughout the process of project design and implementation.

6. The Service has provided technical assistance to PSNERP throughout the entire GI study process. The Service requests that USACE continue to engage with the Service and other natural resource agencies, seeking technical assistance to ensure that benefits to fish and wildlife resource are maximized and short-term adverse effects are minimized.

B. Tier 2 Recommendations: Generating Additional Benefits

1. Per the June 2015 guidance memo from the Office of the Assistant Secretary of the Army for Civil Works, USACE and WDFW have developed a tiered implementation approach for all 36 sites identified and evaluated by the GI study. These sites were deemed critical to restore the connectivity and size of large river delta estuaries, restore the number and quality of coastal embayments, and restore the size and quality of beaches and bluffs. The tiered strategy allows for a more diversified scope of projects to be implemented under various restoration authorities and programs. This Coordination Act Report has focused on the RP and alternatives evaluated in the draft FR/EIS which does not include substantial reference to other sites and implementation pathways. Nonetheless, in addition to the three sites proposed by USACE in their APA/RP, there is significant work to be done outside of an envisioned Nearshore Restoration authority for PSNERP. The Service strongly recommends that USACE adhere to the approach outlined in the guidance memo. This includes aggressive pursuit of opportunities to apply Corps of Engineers' CAP resources (e.g. §1135, §206, §544) to implement those projects deemed more appropriate for CAP implementation than via the PSNERP GI (Categories 2 and 3, Table 4).

2. Similar to recommendation B(1) above, the Service recommends that USACE seek a local sponsor to support the required GI(s) for the nine sites identified as falling within the GI program but require additional data collection and/or analysis that would be studied under future feasibility reports (Category 5, Table 4). These nine sites that require additional study prior to eligibility for authorization would more completely realize the potential provided by the extensive analysis of the PSNERP GI and greatly complement the three sites that are the focus of the current APA/RP.

X. SUMMARY AND THE SERVICE POSITION

The Service supports the tiered approach for implementation agreed upon by USACE and WDFW for projects identified to address the ecosystem restoration needs documented by the analysis completed under the authority of the Puget Sound Nearshore Ecosystem Restoration GI Study. We specifically endorse:

1. Immediate implementation of the APA/RP. USACE and WDFW should continue engineering design and other tasks required to implement the three projects recommended by the GI. Completion of the Nooksack River, North Fork Skagit River, and Duckabush River projects will provide substantial positive benefits to Puget Sound recovery including important benefits for fish and wildlife resources.

2. Aggressive pursuit of opportunities to apply other USACE authorities to implement 12 projects identified by the tiered approach as appropriate for Puget Sound and Adjacent Waters (§544) or CAP (§1135, §206) execution. These projects are within reach of existing authorities and resources and should be implemented as expeditiously as possible.

3. Simultaneous work to develop local sponsorship and USACE vertical team support for additional GI studies to complete additional data collection and analysis required to advance nine projects determined suitable for GI implementation but lacking sufficient information for immediate authorization.

The Service finds substantial value in action alternatives evaluated by the FR/EIS that would have delivered significantly greater ecosystem benefit than the final proposal. However the Service understands that the tiered approach which includes implementation of restoration projects beyond the scope of the APA/RP may provide similar, or perhaps greater, ecosystem benefits than any of the formal NEPA alternatives considered. The path forward agreed upon by USACE Headquarters, USACE Seattle District, and WDFW delivers a desirable outcome in authorizing three significant restoration projects, resulting in over 2,100 acres of tidal wetlands. These projects, especially when complemented by other actions identified in the tiered implementation approach, will substantially improve Puget Sound nearshore ecosystem conditions, addressing degradation identified by the GI study. Nearshore restoration at this scale has the potential to contribute substantially to regional Puget Sound recovery efforts and is consistent with the obligations to uphold treaty reserved rights of western Washington tribes. These projects represent a significant contribution to the urgent need to recover Puget Sound ecosystems providing habitat for fish, wildlife, and plants for the continuing benefit of the American people.

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APPENDIX A: WASHINGTON DEPARTMENT OF FISH AND WILDLIFE COMMENTS

State of Washington
DEPARTMENT OF FISH AND WILDLIFE

Mailing Address: 600 Capitol Way N • Olympia, WA 98501-1091 • (360) 902-2200, TDD (360) 902-2207
Main Office Location: Natural Resources Building • 1111 Washington Street SE • Olympia, WA

February 11, 2016

Curtis Tanner
Environmental Assessment and Restoration Division
U.S. Fish and Wildlife Service
510 Desmond Drive Southeast, Suite 102
Lacey, Washington 98503

Dear Mr. Tanner:

The Washington Department of Fish and Wildlife (Department) submits the following comments in regard to the draft Fish and Wildlife Coordination Act report on the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). The draft report is being prepared under authority of and in accordance with the Fish and Wildlife Coordination Act in fulfillment of the reporting requirements set forth in Section 2(b) of the Act, and is intended to accompany the U.S. Army Corps of Engineers' (Corps) final feasibility report for the PSNERP General Investigation.

The U.S. Fish and Wildlife Service (Service) has coordinated with the Department in the preparation of this draft Fish and Wildlife Coordination Act report on the PSNERP. The document captures the interests of the Department in advancing ecosystem restoration projects in partnership with the Corps.

After reviewing this draft report, we support the recommendations contained therein and concur with the statements provided by the Service in this report. However, the Department is actively developing riparian guidance tools in our Priority Habitats and Species – Riparian document, and thus will rely on the updated science of that work prior to concurring with the NMFS riparian guidance specified in your recommendations.

The Department appreciates the opportunity to review this report and submit comments. If I can be of further assistance, please contact me at (360) 902-2527.

Sincerely,

Jeff Davis, Assistant Director
Habitat Program

APPENDIX B: NATIONAL MARINE FISHERIES SERVICE COMMENTS

Tanner, Curtis <curtis_tanner@fws.gov>

Joint FWCA Report

David Hirsh - NOAA Federal <david.hirsh@noaa.gov> Tue, Feb 16, 2016 at 11:31 AM
To: "Tanner, Curtis" <curtis_tanner@fws.gov>
Cc: Martha Jensen <martha_l_jensen@fws.gov>, Mark Celedonia <mark_celedonia@fws.gov>, Elizabeth Babcock <elizabeth.babcock@noaa.gov>

Dear Curtis--On behalf of the North Puget Sound Branch of the Oregon Washington Coast Area Office of NMFS, I would like to express our strong support for your findings and recommendations presented in the USFWS's Draft CAR on the COE/WDFW PSNERP program in Puget Sound. We recently completed formal consultation on a batch of three projects under that program that we believe will have substantial benefits for the conservation of affected ESA listed salmon and steelhead. These projects have been identified in our salmonid recovery plans covering Puget Sound, and the PSNERP process considered the input of a variety of Agenices and Tribes with local knowlege and species expertise, thereby ensuring well-rounded stakeholder support.

We would like to use this opportunity to suggest the inclusion of a single procedural consideration in your final report regarding the intersection of the PSNERP design process and our Agencies' ESA section 7 duties. Specifically, NMFS recommends that the COE provide detailed design information for each of four stages of design development identified in PSNERP program: 1) Concept (10 percent); 2) 30 percent design; 3) 60 percent design; and 4) 90 percent design. At this time, in the absence of a programmatic consultation that would address all underlying activities proactively and prescriptively, the 10 percent design stage is only sufficient to enable a threshold analysis and might not be sustainable for ESA section 7 compliance over the long term. In contrast, requiring the COE to provide additional design information as design progresses toward construction would enable NMFS to ensure that ESA s7 consultation completed at the 10 percent design stage remains valid or identify new information that might trigger the need to reinitiate consultation.

Presently, we lack an operating programmatic consultation covering these types of actions in Puget Sound. For our recently completed batched consultation, we required the COE to provide that design information for all three projects to ensure the continuing validity of our incidental take statement. NMFS recommends that process continue for all PSNERP actions sent to the Services for ESA consultation until a programmatic consultation can be completed.

Thank you again for the opportunity to review your draft CAR. It was a pleasure collaborating with you and we look forward to doing more of that in the future.

DH

David Hirsh
Division Manager/Senior Program Analyst, Oregon-Washington Coast Area Office
National Marine Fisheries Service, West Coast Region
7600 Sandpoint Way, Building 1
Seattle, WA 98115
(206)-526-4506

[Quoted text hidden]

APPENDIX C: SWINOMISH INDIAN TRIBAL COMMUNITY COMMENTS

Phone (360) 466-3163
Fax (360) 466-5309

Swinomish Indian Tribal Community

A Federally Recognized Indian Tribe Organized Pursuant to 25 U.S.C. § 476
11404 Moorage Way
LaConner, Washington 98257-0817

United States Department of the Interior
Fish and Wildlife Service
Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, WA 98503

February 5, 2016

RE: Puget Sound Nearshore General Investigation

Dear Mr. Rickerson:

The Swinomish Indian Tribal Community (the Tribe) appreciates the opportunity to provide input to the Fish and Wildlife Service's Coordination Act Report (CAR). As you may be aware, the North Fork Skagit River Delta Project was first identified by the Tribe as an important option for estuarine restoration as part of the 2005 Skagit Chinook Recovery Plan. However, it was, and remains, our expectation that considerable technical analysis would be undertaken before this project would be advanced to the next level of design. In particular, we are keenly interested in a thorough evaluation of the sustainability of the habitat to be restored, benefits to ecosystem processes, as well as any potential impacts to the Tribe's important fishing sites in the vicinity of the proposed project. It was therefore of some surprise to learn that this project is on a fast track for authorization before Congress without a full determination as to how Tribal concerns will be addressed.

Clearly the Tribe is supportive of projects that will make significant contributions to chinook and steelhead recovery in the Skagit River. We also know that significant investments are already being made through local and state funding sources to evaluate the hydrologic processes at play in this stretch of the river. We have been eager to see the results of these analysis and understand they are soon to be made available for review. Until such time as we have the opportunity to review and analyze these assessments we believe it is virtually impossible to answer the most basic of questions regarding the pros and cons of this project as proposed.

To illustrate or concerns, changes in the river at this location since the Chinook Recovery Plan was written have resulted in some challenges to the Tribe in our ability to access and

fish in this portion of the river. Most specifically, the accumulation of sediment in one channel of the North Fork in this area has reduced our access to our fishing sites and has resulted in difficulties for fisherman to access this traditional resource. To better understand how this section of river will evolve with or without a project being implemented is essential to the welfare of the Swinomish people. To advance a specific proposal that does not first thoroughly consider the hydrologic ramifications of all alternatives and approaches to design, at a landscape level, seems premature given what is at stake. We do want to see a project move forward, but only after we can adequate assess and mitigate for impacts that may occur. We therefore believe this project should not move forward without assurances that appropriate hydrodynamic studies are conducted such that we can determine how much habitat will be gained, and for how long. Also, we are also concerned that a levee setback may result in additional hardship on Tribal fishermen. We need to understand in adequate detail how a levee setback will effect river navigation and shoreline access as well as salmon habitat. In this regard, we feel that it is necessary that the Tribe be an integral part in any studies that are conducted to assess habitat or riverine impacts, and we would expect to be intimately involved in the design of any of the restoration alternative to insure that Treaty secured fishing activities are not compromised.

We therefore request that this CAR detail our concerns and advocate for Tribal inclusion in the development of any future analysis and in the ultimate project design.

Thank you for your consideration.

Sincerely,

Larry Wasserman
Environmental Policy Director

cc Wetzler, USACE

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental and Cultural Resources Branch

MAR 05 2013

Mr. Reid Nelson
Director, Office of Federal Agency Programs
Advisory Council on Historic Preservation
1100 Pennsylvania Ave. NW, Suite 803
Washington DC 2004-2501

Subject: Puget Sound Nearshore Marine Habitat Restoration Project, Puget Sound vicinity, Washington

Dear Mr. Nelson,

The United States Army Corps of Engineers (Corps), in cooperation with the Washington Department of Fish and Wildlife (WDFW), is currently preparing a feasibility study and ecosystem restoration plan, referred to as the Puget Sound Nearshore Marine Habitat Restoration Project (Nearshore Project), to address significant ecosystem degradation at 18 locations in the nearshore zone of the Puget Sound Basin, Washington (see enclosed fact sheets and maps). Ecological degradation of the nearshore zone is primarily attributable to man-made stressors that have impeded ecosystem processes such as tidal exchange, transport of sediments and freshwater inflow. These man-made stressors include shoreline armoring and bank stabilization, wetland fill, tidal barriers or channel restrictions such as levees, dams and overwater structures such as railroad and highway infrastructure, and marinas, for example. Alternatives being considered within the Nearshore Project will address ecosystem degradation by removing many of these stressors and taking other actions to restore the natural ecosystems. Our review of the Nearshore Project for purposes of Section 106 of the National Historic Preservation Act (NHPA) has concluded that, given the multiple alternatives and locations under consideration and the restricted scope and scale of identification efforts in support of the planning decision, as per the Corps' new Planning SMART framework requirements for projects (see enclosed Planning Smart brochure), a Programmatic Agreement (PA) may be required to manage issues related to the level of effort for inventory and evaluation, effects to historic properties, and other requirements of Section 106. Within the context of a PA, and pursuant to 36 CFR 800.4(b)(2), the Corps proposes to use a phased process to conduct identification and evaluation of historic properties, including the partial deferment of identification and evaluation until the specific aspects or locations of alternatives are more fully defined. Pursuant to 36 C.F.R.

800.6(a)(1)(i)(c), the Corps is inviting the Advisory Council on Historic Preservation (ACHP) to participate in the development of the PA.

The nearshore zone of the Puget Sound is the transitional zone between terrestrial, freshwater, estuary and marine systems. It includes beaches, coastal banks or bluff, shallow waters in estuarine deltas, and tidal lands. These areas support a diverse array of fish, wildlife and plants, including several species listed under the Endangered Species Act. The Corps and WDFW have prepared a draft Feasibility Report/ Environment Impact Statement (FR/EIS) for the Nearshore Project. The FR/EIS takes a programmatic approach for considering restoration plans comprised of multiple locations. The FR/EIS provides a base-line study which utilizes readily-available information and analyzes proposed restoration actions at a 10 percent design level only. As indicated above, the tentatively selected plan (TSP) alternative provides for restoration actions at 18 nearshore locations. These locations are in six of the seven sub-basins around Puget Sound, including the highly productive shellfish regions of south Puget Sound and Hood Canal, and the Strait of Juan de Fuca which is a transition zone between the Pacific Ocean. Eight locations are in coastal embayments and five locations are in one of three major river deltas. All 18 locations contain critical habitat for ESA-listed species. Please refer to the enclosed fact sheets for current conditions and tentative restoration actions proposed at each location.

The cultural resource analysis presented in the FR/EIS is based on a series of preliminary investigations sponsored by the United States Fish and Wildlife Service (USFWS) in 2011. Those investigations were part of a larger study designed to provide baseline environment information for a candidate list of 36 nearshore locations with significant ecosystem degradation issues. The USFWS anticipated the Corps and WDFW would utilize the information to review, prioritize and select locations most appropriate to a request for federal funding. Baseline information collected for candidate locations not selected for the Nearshore Project, alternatively, would be made available to support and expedite final implementation of restoration actions through other federal, local, state or other programs.

Preliminary or baseline investigations for cultural resource concerns included: 1) literature review; 2) reconnaissance inventory; and 3) development of historic context for one of the most prevalent historic-age resources found at nearshore locations, agricultural dikes /levees. The first investigation reviewed existing literature for known and potential cultural resources within the area of potential effects (APE) at all 36 candidate locations. Consulted sources included the Washington Department Archaeology and Historic Preservation's data base of cultural resources reports and documented cultural resource properties, Washington State Register and National Register of Historic Places, and a wide variety of relevant primary and secondary documents. The reconnaissance inventory involved a pedestrian survey of public

lands within the APE of 15 candidate locations, 10 of which became Nearshore Project locations. Findings of the literature review and reconnaissance inventory revealed that 10 of the 18 Nearshore Project locations contain known prehistoric archaeological sites and three contain known historic archaeological sites, all of which could be impacted by restoration actions. Built environment resources identified and proposed for removal are two sections of railroad line, seven railroad bridges, eight highway bridges, nine dike/levee systems, five industrial facilities, fish hatchery, four marine-related research facilities, and numerous agricultural, residential, and commercial buildings.

Context developed for agriculture dikes / levees provided highly useful information for the era of initial construction and use in the 1860s and 1870s, and up to 1910. A more detailed analysis, however, is required for the historic-era post 1910. The Corps' program of upgrading existing agricultural dikes and constructing new levees for flood control purposes is of particular concern.

After approval of the FR/EIS, the Nearshore Project would be submitted to Congress for approval and funding. Once funding is authorized, the Corps would prepare Environment Assessments (EA) for each of the restoration project authorized for construction. At that point, each individual restoration project would be fully designed and analyzed within a project specific EA.

In addition to the ACHP, the Corps has notified the Washington State Historic Preservation Officer about the development of a PA and is also identifying and inviting parties who might be interested in consulting on the PA, including Indian tribes, Historic Preservation Commissions of certified local governments, WDFW and other government agencies and members of the public with a demonstrated interested in cultural or historical components of the Nearshore Project. We anticipate the PA would provide a process for completing the identification and evaluation of possible historic properties as the alternatives are refined and the projects are approved and funded, determining effects on historic properties, and addressing post-review discoveries of archaeological sites and inadvertent discoveries of human remains. We may also consider identifying best management practices or standard treatments of certain properties or effects, and the manner in which the Corps will conclude its Section 106 responsibilities for these individual actions.

As noted at the outset of this letter, our primary purpose is to notify you of the Nearshore Project and invite you to participate in the development of PA as provided at 36 C.F.R. § 800.6(a)(1)(i)(c). As we move forward in consultation with the consulting parties to develop the draft agreement document for this undertaking, we would appreciate any advice and guidance you might provide.

We look forward to our consultations with your office on this undertaking. For more information about this project or clarification about this request, please contact Ms. Mary McCormick (Cultural Resources Lead) by telephone at (206) 316-3938 or by email at mary.e.mccormick@usace.army.mil. I can be reached by telephone at (206) 316-3096 or by email at rolla.l.queen@usace.army.mil.

Sincerely,

Rolla Queen, Chief
Cultural Resources Section
Environmental and Cultural Resources Branch

cc with enclosures

CENWS-EN-ER
SUBJECT: SECTION 106 Letter to ADHP requesting participation in development of Programmatic Agreement for identification and treatment of historic properties with potential for impact by the Puget Sound Nearshore Marine Habitat Restoration Project, Washington.

MCCORMICK/EN-ER mm 3/5/13
QUEEN/EN-ER 3/5/13

EN-ER Files

Milford Wayne Donaldson
Chairman

Clement A. Price
Deputy Chairman

John M. Fowler
Executive Director

Preserving America's Heritage

March 22, 2013

Lieutenant General Thomas P. Bostick
Commanding General
U.S. Army Corps of Engineers
441 G. Street, NW
Washington, DC 20314-1000

REF: Puget Sound Nearshore Marine Habitat Restoration Project, Washington State

Dear General Bostick:

The Seattle District of the Corps of Engineers has requested that the Advisory Council on Historic Preservation (ACHP) participate in the development of a Programmatic Agreement to help ensure that historic properties are fully considered as the Seattle District implements the referenced Nearshore Project. Pursuant to the Criteria for Council Involvement in Reviewing Individual Section 106 Cases (Appendix A to our regulations, 36 CFR Part 800) we believe the criteria are met for our participation in this undertaking. The restoration of natural ecosystems in Puget Sound and the activities associated with it (including removal of ecosystem stressors and enhancement of tidal exchange, sediment transport, and freshwater inflow) have the potential to adversely affect important historic properties, and may present questions of policy or interpretation. Accordingly, we will participate in consultation with the Seattle District on this undertaking.

By copy of this letter we are also notifying Mr. Rolla Queen, Chief of the Seattle District's Cultural Resources Section, of our decision to participate in consultation.

Our participation will be handled by Dr. Tom McCulloch, who can be reached at 202-606-8554 or at tmcculloch@achp.gov. We look forward to working with the Corps on this important project.

Sincerely,

John M. Fowler
Executive Director

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental and Cultural Resources Branch

MAR 05 2013

Dr. Allyson Brooks, Ph.D.
State Historic Preservation Officer
Department of Archaeology and Historic Preservation
P.O. Box 48343
Olympia, WA 98504

Subject: Section 106 Notification and Review of the Puget Sound Nearshore Marine Habitat Restoration Project, vicinity of Puget Sound, Washington

Dear Dr. Brooks:

The United States Army Corps of Engineers (Corps), in cooperation with the Washington Department of Fish and Wildlife (WDFW), is currently preparing a feasibility study and ecosystem restoration plan, referred to as the Puget Sound Nearshore Marine Habitat Restoration Project (Nearshore Project), to address significant ecosystem degradation at 18 locations in the nearshore zone of the Puget Sound Basin, Washington (see enclosed fact sheets and maps). Ecological degradation of the nearshore zone is primarily attributable to man-made stressors that have impeded ecosystem processes such as tidal exchange, transport of sediments and freshwater inflow. These man-made stressors include shoreline armoring and bank stabilization, wetland fill, tidal barriers or channel restrictions such as levees, dams and overwater structures such as railroad and highway infrastructure, and marinas, for example. Alternatives being considered within the Nearshore Project will address ecosystem degradation by removing many of these stressors and taking other actions to restore the natural ecosystems. Our review of the Nearshore Project for purposes of Section 106 of the National Historic Preservation Act (NHPA) has concluded that, given the multiple alternatives and projects under consideration and the restricted scope and scale of identification efforts in support of the planning decision, a Programmatic Agreement (PA) may be required to manage issues related to the level of effort for inventory and evaluation, effects to historic properties, and potential management strategies. Within the context of a PA, and pursuant to 36 CFR 800.4(b)(2), the Corps proposes to use a phased process to conduct identification and evaluation of historic properties, including the partial deferment of identification and evaluation until the specific aspects or locations of alternatives are more fully defined. The Corps is also notifying the Advisory Council on Historic Preservation (ACHP) as required at 36 C.F.R. 800.6(a)(1)(i)(c) and inviting them to participate in the development of the PA.

The nearshore zone of the Puget Sound is the transitional zone between terrestrial, freshwater, estuary and marine systems. It includes beaches, coastal banks or bluff, shallow waters in estuarine deltas, and tidal lands. These areas support a diverse array of array of fish, wildlife and plants, including several species listed under the Endangered Species Act. The Corps and WDFW have prepared a draft Feasibility Report/ Environment Impact Statement (FR/EIS) for the Nearshore Project. The FR/EIS takes a programmatic approach for considering restoration plans comprised of multiple locations. The FR/EIS provides a baseline study which utilizes readily-available information and analyzes proposed restoration actions at a 10 percent design level only. As indicated above, the tentatively selected plan (TSP) alternative provides for restoration actions at 18 nearshore locations. These locations are in six of the seven sub-basins around Puget Sound, including the highly productive shellfish regions of south Puget Sound and Hood Canal, and the Strait of Juan de Fuca which is a transition zone between the Pacific Ocean. Eight locations are in coastal embayments and five locations are in one of three major river deltas. All 18 locations contain critical habitat for ESA-listed species. Please refer to the enclosed fact sheets for current conditions and tentative restoration actions proposed at each location.

The cultural resource analysis presented in the FR/EIS is based on a series of preliminary investigations sponsored by the United States Fish and Wildlife Service (USFWS) in 2011. Those investigations were part of a larger study designed to provide preliminary baseline environmental information for a candidate list of 36 nearshore locations with significant ecosystem degradation issues. The USFWS anticipated the Corps and WDFW would utilize the information to review, prioritize and select locations most appropriate to a request for federal funding. Baseline information collected for candidate locations not selected for the Nearshore Project, alternatively, would be made available to support and expedite final implementation of restoration actions through other federal, local, state or other programs.

Preliminary or baseline investigations for cultural resource concerns included: 1) literature review; 2) reconnaissance inventory; and 3) development of historic context for one of the most prevalent historic-age resources found at nearshore locations, agricultural dikes /levees. The first investigation reviewed existing literature for known and potential cultural resources within the area of potential effects (APE) at all 36 candidate locations. Consulted sources included the Washington Department Archaeology and Historic Preservation's data base of cultural resources reports and documented cultural resource properties, Washington State Register and National Register of Historic Places, and a wide variety of relevant primary and secondary documents. The reconnaissance inventory involved a pedestrian survey of public lands within the APE of 15 candidate locations, 10 of which became Nearshore Project locations. Findings of the literature review and reconnaissance inventory revealed that 10 of the 18

Nearshore Project locations contain known prehistoric archaeological sites and three contain known historic archaeological sites, all of which could be impacted by restoration actions. Built environment resources identified and proposed for removal are two sections of railroad line, seven railroad bridges, eight highway bridges, nine dike/levee systems, five industrial facilities, fish hatchery, four marine-related research facilities, and numerous agricultural, residential, and commercial buildings.

Context developed for agriculture dikes / levees provided highly useful information for the era of initial construction and use in the 1860s and 1870s, and up to 1910. A more detailed analysis, however, is required for the historic-era post 1910. The Corps' program of upgrading existing agricultural dikes and constructing new levees for flood control purposes is of particular concern.

After approval of the FR/EIS, the project would be submitted to Congress for approval and funding. Once funding is authorized, the Corps would prepare Environment Assessments (EA) for each of the restoration projects authorized for construction. At that point, each individual restoration project would be fully designed and analyzed within a project specific EA.

In addition to the Washington State Historic Preservation Officer and Tribal Historic Preservation Officers, the Corps is in the process of identifying consulting parties who might be interested in consulting on the PA, including Indian tribes, Historic Preservation Commissions of certified local governments, WDFW and other government agencies and members of the public with a demonstrated interested in cultural, historical or social components of the Nearshore Project. We anticipate the PA would provide a process to continue identification and evaluation of possible historic properties as the alternatives are refined and the projects are approved and funded, determining effects on historic properties, and addressing post-review discoveries of archaeological sites and inadvertent discoveries of human remains. We may also consider identifying best management practices or standard treatments of certain properties or effects, and the manner in which the Corps will conclude its Section 106 responsibilities for these individual actions.

As noted at the outset of this letter, our primary purpose is to notify you of the Nearshore Project and our request to phase and defer identification and evaluation of historic properties as provided at 36 C.F.R. § 800.4(b)(2) through the development of a PA as provided at 36 C.F.R. § 800.14(b). As we move forward in consultation with the other consulting parties and your office to develop the draft agreement document for this undertaking, we would appreciate any advice and guidance you might provide.

We look forward to our consultations with your office on this undertaking. For more information about this project or clarification about this request, please contact Ms. Mary McCormick (Cultural Resources Lead) by telephone at (206) 316-3938 or by email at mary.e.mccormick@usace.army.mil. I can be reached by telephone at (206) 316-3096 or by email at rolla.l.queen@usace.army.mil.

Sincerely,



Rolla Queen, Chief
Cultural Resources Section
Environmental and Cultural Resources Branch

cc with enclosures

CENWS-EN-ER
SUBJECT: SECTION 106 Letter to SHPO requesting participation in development of Programmatic Agreement for identification and treatment of historic properties with potential for impact by the Puget Sound Nearshore Marine Habitat Restoration Project, Washington.

MCCORMICK/EN-ER mm 3/5/13
QUEEN/EN-ER 3/5/13

EN-ER Files

DEPARTMENT OF
ARCHAEOLOGY &
HISTORIC PRESERVATION
Protect the Past, Shape the Future

Allyson Brooks Ph.D., Director
State Historic Preservation Officer

April 3, 2013

Ms. Rolla Queen
Cultural Resource Section Chief
US Army Corps of Engineers
PO Box 3755
Seattle, WA 98124-3755

In future correspondence please refer to:
Log: 040313-10-COE-S
Property: Puget Sound Near-shore Marine Habitat Restoration Programmatic Agreement
Re: More Information Needed

Dear Ms. Queen:

Thank you for contacting the Department of Archaeology and Historic Preservation (DAHP). I have reviewed the materials you provided for this project. We look forward to working with you, the US Army Corps of Engineers and the US Department of Fish and Wildlife in developing a Programmatic Agreement in the coming months to mitigate for cultural resource concerns while enhancing near-shore habitat and ecosystems.

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer pursuant to Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800. Please contact me should you have any specific questions about our request and we look forward to having an opportunity to review and comment on the draft programmatic agreement when it is available.

Thank you for notifying DAHP of the opportunity. Should you have any questions, please feel free to contact me.

Sincerely,

Russell Holter
Project Compliance Reviewer
(360) 586-3533
russell.holter@dahp.wa.gov

Tribal Correspondence Summary:

Tribal Name	Date of Notification		
Confederated Bands of the Yakama Nation		Oct 23, 2014	Sep 4, 2015
Hoh Indian Tribe	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Jamestown S'Klallam Indian Tribe	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Lower Elwha Klallam Business Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Lummi Business Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Makah Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Muckleshoot Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Nisqually Tribe	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Nooksack Indian Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Port Gamble S'Klallam Business Committee	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Puyallup Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Quileute Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Quinault Nation Business Committee	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Samish Indian Nation	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Sauk-Suiattle Indian Tribe	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Skokomish Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Snoqualmie Tribe	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Squaxin Island Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Stillaguamish Board of Directors	Aug 2, 2012		Sep 4, 2015
Suquamish Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Swinomish Indian Senate	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
The Tulalip Tribes	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Upper Skagit Tribal Council	Aug 2, 2012	Oct 23, 2014	Sep 4, 2015
Yakama Tribal Council	Aug 2, 2012	Oct 23, 2014	
Tribal Organizations			
NW Indian Fisheries Commission	Aug 2, 2012		Sep 4, 2015

Sample September 2015 correspondence

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

SEP - 4 2015

Civil Works Branch

The Honorable [Name]
Chair/President, [Tribal Name]
[Address]
[Town], Washington [Zip Code]

Dear Chairperson/President [Name]:

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a multi-year partnership between the U.S. Army Corps of Engineers (Corps) and the Washington Department of Fish and Wildlife to formulate, evaluate, and select an ecosystem restoration plan for sites across Puget Sound. The purpose of this letter is to follow up to our October 23, 2014 letter to notify you of the progress and status of the PSNERP.

At the time of our 2014 letter, the PSNERP team had reduced the potential list of restoration sites from 36 potential restoration sites to a Tentatively Selected Plan of 11 potential restoration sites. Since 2014, a tiered-implementation strategy has been developed to implement all 36 sites under various restoration authorities and partners. Sites were selected based on restoration potential, restoration opportunity, and local support. Of the 36 sites, 3 are being recommended for construction authorization under the existing Corps feasibility study and will be presented as the recommended plan in the Final Feasibility Report and Environmental Impact Statement. These three sites include the Duckabush River Estuary, Nooksack River Delta, and North Fork Skagit River Delta. In addition, 9 of the 36 sites are recommended for further Corps study. Eight medium-sized projects are identified for future implementation under the Corps' Continuing Authorities Program (CAP), and four small projects are identified for future implementation under the Corps' Puget Sound and Adjacent Waters (PSAW) authority. Sites implemented under CAP or PSAW will go through a separate National Environmental Policy Act /consultation process at a future date. Finally, 12 sites are identified for implementation by other agencies. The enclosed strategy paper provides additional information about the tiered-implementation approach for each of the 36 sites, including more-specific information about the 3 sites being recommended for construction authorization.

I look forward to working with you to continue important nearshore restoration activities. If you have any questions about the status of a project or the PSNERP study process, please do not hesitate to contact the District Tribal Liaison Lori Morris at (206) 764-3625 or via email at frances.morris@usace.army.mil. For additional information about the PSNERP, please contact the Project Manager Lynn Wetzler at (206) 764-3695 or via email at lynn.wetzler@usace.army.mil.

Sincerely,

John G. Buck
Colonel, Corps of Engineers
District Commander

Enclosure

cc with enclosure:

Sample October 2014 correspondence

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental and Cultural Resources Branch

OCT 23 2014

The Honorable [Name]
Chair/President, [Tribal Name]
[Address]
[Town}, Washington [Zip code]

Dear Chairperson/President [Name]

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a multi-year partnership between the U.S. Army Corps of Engineers (Corps) and the Washington Department of Fish and Wildlife (WDFW) to formulate, evaluate, and select an ecosystem restoration plan for sites across Puget Sound. The purpose of this letter is to follow up to our August 2, 2012 letter to notify you of the progress and status of the PSNERP. At the time of our 2012 letter, the PSNERP team had reduced the potential list of restoration sites from 36 potential restoration sites to 15 potential restoration sites. Since 2012, the list of restoration sites has been further refined to 11 sites. The current 11-site Preferred Alternative/Tentatively Selected Plan (TSP) has resulted from review in accordance with Corps regulation and guidance. I would like to offer you an opportunity to meet with us to discuss the 11 proposed restoration sites and provide more information on the study.

The currently proposed 11 ecosystem restoration sites were chosen after the PSNERP team undertook a comprehensive analysis of historical and current conditions in the Puget Sound nearshore zone. The study team evaluated more than 500 potential restoration sites, identifying the best places and opportunities to improve the nearshore zone's ability to provide locally and nationally valued resources. The currently proposed 11 sites in the TSP will restore an estimated 5,300 acres of nearshore ecosystems with an estimated total project cost of about $1.1 billion.

The Corps and WDFW have prepared an integrated Draft Feasibility Report and Environmental Impact Statement (FR/EIS) that takes a basin-wide approach for considering restoration plans at the proposed 11 restoration sites. The draft FR/EIS is undergoing a 45-day public comment period and is available for review at http://bit.ly/PSNearshore. The public comment period is October 10 through November 24, 2014.

After approval of the Final FR/EIS at Corps headquarters, we anticipate that the project will be submitted to Congress for final approval and funding. Authorization by Congress and project implementation is likely several years away. Once authorized, each of the proposed 11 restoration sites would need to receive Federal appropriations before further design and implementation work could occur. Enclosed is a map and brief description of each of the 11 proposed restoration sites.

I look forward to working with you to continue important Nearshore restoration activities. If you have any questions about the status of a project, the PSNERP study process, or wish to participate in either a staff level meeting or a formal Government-to-Government meeting, please do not hesitate to contact the District Tribal Liaison, Lori Morris, at (206) 764-3625 or via email at frances.morris@usace.army.mil. For additional information about the PSNERP, please contact the Project Manager, Lynn Wetzler, at (206) 764-3695 or via email at lynn.wetzler@usace.army.mil.

Sincerely,

John G. Buck
Colonel, Corps of Engineers
District Commander

Enclosure

Sample August 2012 correspondence

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Civil Works Branch

AUG 2 - 2012

The Honorable [Name]
Chair/President, [Tribal Name]
[Address]
[Town}, Washington [Zip code]

Dear Chairperson/President [Name]

I am sending you this letter to notify you of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) teams' progress in project selection and to obtain your opinion and, ideally, your support for these projects. I would also like to offer you an opportunity to meet with us to further discuss these projects and the overall restoration study. This could occur at either the staff level or though a Government-to-Government consultation meeting. A staff-level meeting with us would not be intended to replace a Government-to-Government meeting between our respective governments. As you are aware, you may request a Government-to-Government meeting with the U.S. Army Corps of Engineers (Corps) at any time during the development of this project, and we invite you--as a Federally recognized Tribe--to participate in consultation with the Corps so that your concerns are identified and addressed prior to making a final decision on project selection for the PSNERP General Investigation study.

As you also may be aware, the PSNERP--a partnership between the Corps and the Washington Department of Fish and Wildlife--has been studying problems and opportunities related to the Puget Sound Nearshore ecosystem and evaluating potential solutions. The local community, including Tribal governments, provided the PSNERP with an extensive listing of potential project ideas throughout Puget Sound.

Of the nearly 700 projects initially identified, the PSNERP teams used scientific tools and criteria to initially narrow the potential list to 36 projects and finally to 15 projects--each addressing identified nearshore restoration and/or protection priorities for Puget Sound. The 15 projects will be included in a draft feasibility report and programmatic Environmental Impact Statement (EIS) that will be submitted to Congress for potential Federal authorization. A map and brief descriptions of each of the final 15 projects are included as an enclosure. Once authorized, each of the 15 projects will need to receive Federal appropriations before further design and implementation work could occur.

The PSNERP team is working diligently to complete the draft feasibility report and EIS this year. Subsequent review and revision work will take several months, while potential authorization by Congress and project implementation is likely several years away. If you would like to schedule a meeting with my staff to better understand the PSNERP project and timeline, how projects in your area of interest fit into the bigger picture, and what the next steps are, please do not hesitate to contact us.

As part of our work, PSNERP has collected significant information that may be useful to you as you continue to pursue restoration opportunities within Puget Sound. This information includes more-specific information on projects that are not being pursued for construction through the PSNERP authorization. We will make this information available to you upon request.

I look forward to working with you to advance important nearshore restoration and protection activities. If you have any questions about that status of a project or the PSNERP process or wish to participate in a Government-to-Government consultation or staff-level meeting, please do not hesitate to contact my Tribal Liaison, Lori Morris, at (206) 764-3625 or frances.morris@usace.army.mil. For additional information about the project, please contact the Project Manager, Jessica Winkler, at (206) 764-3462 or jessica.g.winkler@usace.army.mil.

Sincerely,

Bruce A. Estok
Colonel, Corps of Engineers
District Commander

Enclosure

CLEAN WATER ACT SECTION 404(b)(1) EVALUATION
PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT
WASHINGTON STATE
January 2016

1. Introduction. The purpose of this document is to record the Corps' evaluation and findings regarding the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) pursuant to Section 404 of the Clean Water Act (CWA). This document covers placement of excavated material at the three project sites listed below and shown in Figure 1 within the waters of the U.S. as part of PSNERP. This project will involve placement of fill below Ordinary High Water (OHW) in riverine areas and placement of fill below Mean Higher High Water (MHHW) in marine areas:

- Nooksack River Delta, Ferndale, WA
- North Fork Skagit River Delta, La Conner, WA
- Duckabush River Estuary, Jefferson County, WA

The information contained in this document reflects the findings of the project record. Specific sources of information included the following:

a. *Historical Change and Impairment of Puget Sound Shorelines: Atlas and Interpretation of Puget Sound Nearshore Ecosystem Restoration Project Change Analysis* (Simenstad et al. 2011)
b. *Implications of Observed Anthropogenic Changes to the Nearshore Ecosystems in Puget Sound* (Fresh et al. 2011)
c. *Management Measures for Protecting the Puget Sound Nearshore* (Clancy et al. 2009)
d. *PSNERP Strategic Restoration Conceptual Engineering – Final Design Report* (ESA et al. 2011)
e. PSNERP Final Feasibility Report/EIS (FR/EIS; USACE *in preparation*)
f. 404(b)(1) Evaluation (see below)
g. Public Interest Review (see below)

This document addresses the substantive compliance issues of the Clean Water Act 404(b)(1) Guidelines [40 CFR §230.12(a)] and Public Interest Factors [33 CFR §320.4 as reference].

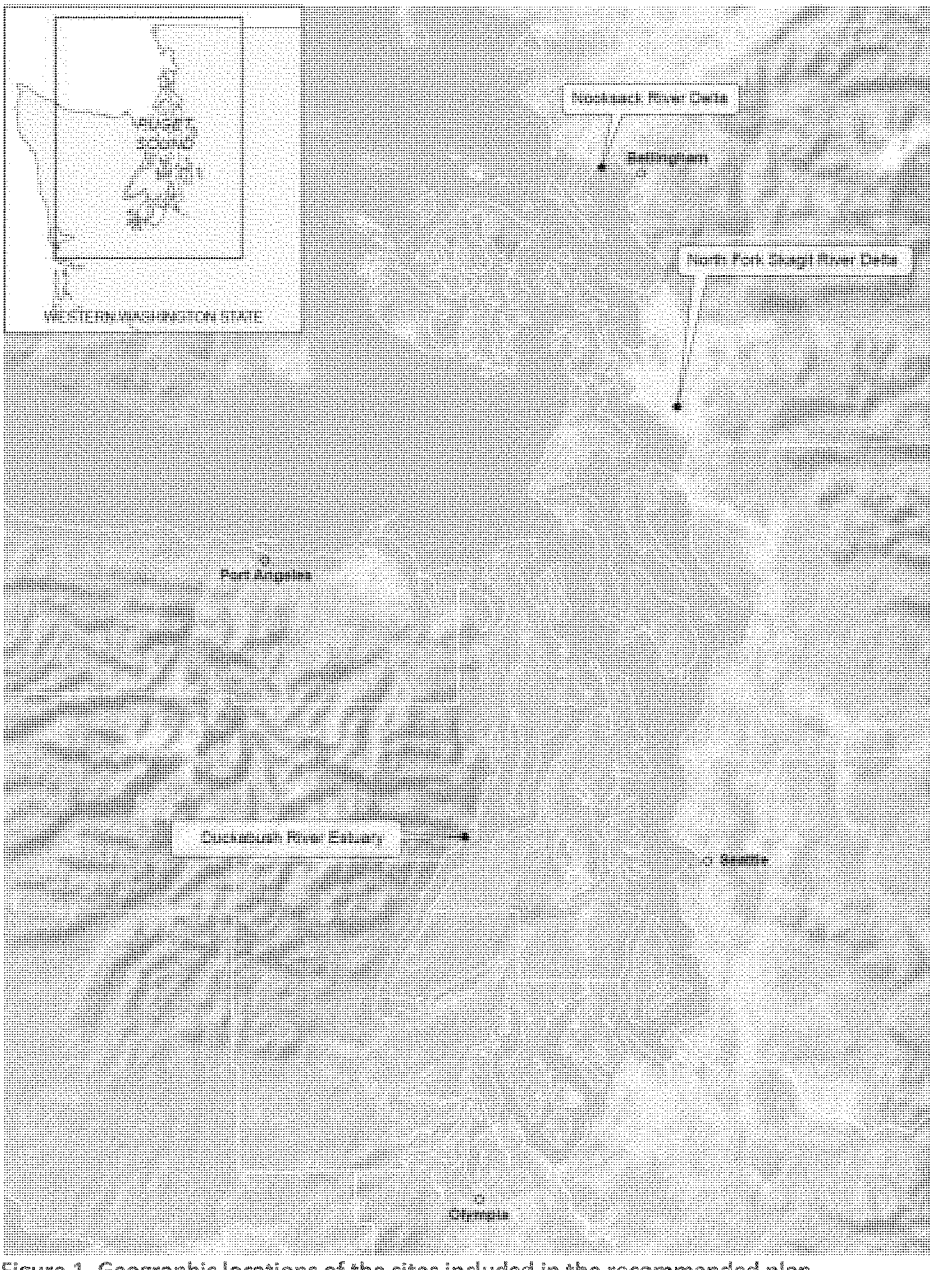

Figure 1. Geographic locations of the sites included in the recommended plan.

2. Description of Proposed Discharge.

The three sites of the preferred alternative will each have excavation and fill or discharge below their relevant jurisdictional line as listed in Table 1. Some discharge may occur incidentally along with the various types of excavation required at each site. Some site restoration plans involve filling of drainage ditches to restore natural site hydrology, and some plans involve discharge of excavated material to restore a more complex topography. General project descriptions are located in Chapter 6 of the FR/EIS and complete descriptions of all features appear in Appendix B – Engineering Appendix of the FR/EIS. Table 1 lists the types of excavation, fill, discharge, and whether the jurisdictional consideration is mean higher high water (MHHW) for the marine environments or the OHW for riverine environments.

Table 1. Fill type and jurisdictional line for each of the 3 sites in the recommended plan.

Site	Acres	Excavation	Fill and/or discharge	Water body type	Jurisdictional line type
Nooksack River Delta	1807	Dredging (regrading of the Lummi River), levee removal,	install diversion at Lummi/Nooksack confluence, install wide-span bridge pilings at 6 locations	tidal fresh	OHW
North Fork Skagit River Delta	256	excavate channels; levee breaches; remove levees, fill, and roads	sidecast material	tidal fresh	OHW
Duckabush River Estuary	38	Excavate channels, removal of culverts, reconstruct Pierce Slough	install wide-span bridge pilings	estuarine mixing	MHHW and OHW

Types of materials that may be discharged during construction will be native materials that have been excavated on site and discharged as sidecast material if beneficial for the restoration purpose. Bridge abutments and pilings will be constructed of concrete suitable for aquatic use. Bridge abutments will be above the OHW mark.

3. Project Purpose and Need.

The purpose of the proposed action is to restore the natural processes in the nearshore zone that sustain the ecological resources important to the people of the Puget Sound region and the nation. Removal of stressors such as shoreline armoring, bank stabilization, tidal barriers, wetland fill, overwater structures, and tidal channel restrictions including levees will allow natural processes to recover. These processes support fish and wildlife and promote the ecosystem structures and functions provided by wetlands, kelp and eelgrass beds, and riparian vegetation including critical habitat for species listed under the Endangered Species Act (ESA).

Valuable natural resources in Puget Sound have declined to a point that the ecosystem may no longer be self-sustaining without intervention to curtail ecological degradation. Impairment of

nearshore processes and degradation of ecosystem functions are critical factors in the declining health of Puget Sound. Anthropogenic stressors causing this impairment and degradation include the direct effects of physical alterations to the landscape that have eliminated large expanses of habitat and have disrupted the major ecological processes that create and sustain habitats. The degradation and loss of nearshore ecosystems is of critical concern because the nearshore zone serves as the connection between terrestrial, freshwater, and marine ecosystems. This means that the nearshore zone vitality, resilience, and productivity influence the productivity of the entire Puget Sound Basin. Alterations to nearshore physiographic processes directly affect the ecosystem functions that support biodiversity and productivity.

The purpose of the material disposal component of the project varies by location. Some sites provide for beneficial re-use of native material excavated on site, and others require the placement of wide-span bridge abutments and pilings. These purposes are used in the analysis of impact avoidance and minimization.

4. Availability of Less Environmentally Damaging Practicable Alternatives to Meet the Project Purpose. The FR/EIS discusses 4 alternatives that the Corps analyzed for the proposed action:

Alternative 1 (No Action):

This alternative is included for comparison purposes and represents future conditions without implementation of a large-scale Federal restoration project. Degradation trajectories would continue as influenced by development and existing restoration and protection authorities. Physical stressors of human influence on the nearshore zone such as fill, armoring, overwater structures, and other types of development would continue to impair water quality. These structures replaced wetlands and preclude the re-establishment of wetlands around Puget Sound that provide valuable water filtration and pollutant sequestration functions.

Alternative 2: Restore 11 Nearshore Zone Sites

Alternative 2 includes 11 sites. The majority of these 11 sites are focused around the Skagit and Snohomish River Deltas, with one site on the stretch of shoreline between Tacoma and Seattle (Beaconsfield) and one to the north in the San Juan Islands (Deer Harbor). Sites are distributed in four of the seven Puget Sound sub-basins defined by PSNERP (see Figure 1-1 in the FR/EIS). Sites in this alternative range from six to 1,807 acres for a total area of 5,354 acres of restored wetland and aquatic habitat.

The 11 sites in this alternative include the following:

- Beaconsfield Feeder Bluff
- Deepwater Slough
- Deer Harbor Estuary
- Dugualla Bay
- Everett Marshland
- Livingston Bay
- Milltown Island
- Nooksack River Delta
- North Fork Skagit River Delta

- Spencer Island
- Telegraph Slough

Alternative 3: Restore 18 Nearshore Zone Sites

Alternative 3 includes 18 sites. These sites are geographically diverse, representing excellent process-based restoration opportunities across the entire Puget Sound nearshore zone. These sites range from the Nooksack River estuary in northern Puget Sound to the WDNR Budd Inlet beach in the South Sound, as well as three sites in Hood Canal, one in Discovery Bay on the Strait of Juan de Fuca, and several sites in between. Sites are distributed in six of the seven Puget Sound sub-basins defined by the Nearshore Study. The sites range from two to 1,807 acres for a total area of restored wetland and aquatic habitat of 5,523 acres.

The 18 sites in this alternative include all 11 sites in Alternative 2, plus these additional sites:

- Big Beef Creek Estuary
- Duckabush River Estuary
- Harper Estuary
- Point Whitney Lagoon
- Snow Creek and Salmon Creek Estuary
- Tahuya River Estuary
- WDNR Budd Inlet Beach

Alternative 3 contains all of the same types of fill and discharge as Alternative 2 and would have all of the same types of construction impacts with similar types of long-term gain in aquatic ecosystem function.

Alternative 4: Restore 3 Nearshore Zone Sites

Alternative 4 includes three of the sites that were analyzed in Alternatives 2 and 3. After release of the Draft FR/EIS, the Corps reformulated the overall program strategy to arrive at a comprehensive plan for implementation of 36 sites under various Corps restoration authorities. The resulting strategy from this analysis is to recommend three sites for near-term authorization with final design and implementation as described here in Alternative 4. Two of these sites are located in northern Puget Sound and the third site is located on the western side of Hood Canal. This recommended plan is not as geographically diverse as Alternatives 2 and 3, but can be implemented with an earlier start date than the larger alternatives, and will lead the way for the strategy of restoring all 36 sites of the PSNERP plan.

- Nooksack River Delta
- North Fork Skagit River Delta
- Duckabush River Estuary

Aspects common to all of the Action Alternatives

Each of these project sites among Alternatives 2, 3, and 4 is a water-dependent activity because the purpose and need for the project is to achieve ecosystem restoration at each of the various

types of aquatic habitat represented by the sites. Components of these sites that involve fill below OHW or MHHW are the filling of drainage channels that prevent wetland establishment, installing culverts or wide-span bridges for fish passage, sediment transport process restoration that assists with forage fish spawning, water diversion for improved water quantity and quality.

Effects to water quality from filling drainage channels would be temporary, limited turbidity within the canals and in the immediate vicinity of their outlet; however, the majority of these channels will be dry as the Corps would work during the driest months of the year and use strategic construction sequencing to avoid unnecessary impacts. No fish inhabit the channels that run through agricultural fields, although some loss of aquatic invertebrate life may occur. Removal of old pilings would likely cause a small area of turbidity on the order of tens of square feet in shallow subtidal habitat. Turbidity would dissipate quickly and would not be substantial enough to bury organisms. Any beach nourishment that may occur would be accomplished in dry conditions, but the first tide waters that inundate the site may wash any remaining sediment across the beach for a temporary turbidity disturbance. Fish would be able to avoid the area and the quantity would not be substantial enough to cause mortality of invertebrates.

For sites in which the Corps will excavate distributary channels and then sidecast the material, sidecasting is the environmentally preferred alternative as it achieves the purpose of restoration of micro-topography at these sites. The combination of excavating channels, then creating swales with the sidecast material immediately improves the complexity of elevations at the site, and will allow for plantings on top of the sidecast material and survive the newly established tidal inundation. Excavation to breach and remove levees would likely occur during low water levels when the work can occur in the dry. As with beach nourishment sites, the first tide waters that inundate these sites will cause turbidity; however, fish are expected to be able to avoid areas of turbidity and the quantity of sediment that becomes suspended in the water would not be substantial enough to cause mortality of invertebrates or to inhibit photosynthesis of any nearby submerged aquatic vegetation. For installation of culverts and wide-span bridges, some turbidity will be associated with stream/river diversion, pile and bridge abutment installation, then reintroduction to the improved channel. Turbidity typically endures for several hours before completely dissipating at these types of projects. For the installation of a permanent diversion structure at the confluence of the Lummi and Nooksack Rivers, a temporary block will be placed during construction. Turbidity is anticipated to be minimal during construction. Isolation devices may be used to minimize turbidity impacts, as well as physical impacts to aquatic species. Reintroduction of water to the site would be similar to what occurs at a typical culvert replacement site. All temporary degradation of water quality caused during construction would be minor and would dissipate within hours of the disturbance.

Findings. The Corps rejected Alternative 1 because it would not meet the project purpose and need to restore the natural processes in the nearshore zone that sustain biological resources including wetlands that provide natural filtration and improve water quality. As described in the FR/EIS, the PSNERP team evaluated a list of 36 potential restoration sites. Since identification of the 11-site alternative (Alternative 2) and 18-site alternative (Alternative 3), a tiered-implementation strategy has been developed to implement all 36 sites with various restoration

authorities and partners. Sites were selected based on restoration potential, restoration opportunity, and local support. Of the 36 sites, three are being recommended for construction authorization under the existing Corps feasibility study and are presented as the recommended plan (preferred alternative; Alternative 4) in the FR/EIS. Designs are at the conceptual level of detail, so precise quantification of impacts is not available; however, means and methods of construction and project locations were analyzed and compared for their minimization of environmental impacts to aquatic habitats and water quality.

Impacts associated with fill and discharge from Alternative 4 are substantially less than those in Alternatives 2 and 3 due to its smaller scale. These impacts include elevated turbidity, noise, and physical disturbance from the excavation of channels, regrading of the Lummi River, removal of roads, levees, narrow bridges, and culverts and installation of wide-span bridge pilings. Alternative 4 would have a similar long-term gain in aquatic ecosystem function as Alternatives 2 and 3, but to lesser extent. Alternative 4 is a small, near-term component of the overall strategy for implementation of 36 sites.

5. Significant Degradation, Either Individually or Cumulatively, To the Aquatic Environment

a. Impacts on Ecosystem Function. Activities conducted for this project will not adversely affect environmental concerns such as water, air, noise, aesthetics, or public access except during construction. These effects were described in the alternatives above and will be discussed in the relevant sections of the 404(b)(1) evaluation below. The activities will improve the physical, chemical, and biological characteristics of the aquatic environment. Significant areas of wetlands will be restored, enhanced, or established, which may result in the alteration or conversion of some types of wetlands. Freshwater tidal wetlands may convert to saltwater-influenced wetlands as tidal flow and prism are restored and some vegetation types may shift toward salt-tolerant plants. Small portions of wetlands may be temporarily impacted by construction activities such as staging and access; however, these wetland areas will be fully restored. There will be no permanent degradation to ecosystem function as a result of this project.

b. Impacts on Recreational, Aesthetic, and Economic Values. No significant adverse effects on recreation, aesthetics, or the economy are anticipated from the restoration proposal, nor have these types of effects occurred during previous similar restoration actions in the Puget Sound nearshore zone. The elimination of one small marina is not expected to reduce boat-based recreation; the activity would likely remain in the area but relocate to nearby facilities.

Findings. The Corps has determined that there would be no significant adverse effects to aquatic ecosystem functions and values. The proposed action will not cause significant degradation, either individually or cumulatively to the aquatic environment.

6. Appropriate and Practicable Measures to Minimize Potential Harm to the Aquatic Ecosystem.

a. Impact Avoidance Measures. The Corps will avoid and minimize impacts to waters of the U.S. to the maximum extent practicable at the project sites. Implementation would involve three ecosystem restoration sites with construction near ecological resources. Through the analysis of potential effects of each of the proposed sites, certain potential adverse effects

were identified. Each of the proposed sites would have short-term construction-related effects with varying spatial and temporal scales and degrees of intensity. Construction designs would include practices that avoid and minimize effects to affected significant resources. Some of these avoidance measures include the following:

- The Corps would schedule in-water work to occur during designated in-water work windows consistent with recommended periods established by WDFW per Washington Administrative Code (WAC) 220-110-271.
- The Corps would schedule work outside of bird nesting season except where unavoidable.
- Each construction contractor would be required to prepare an Environmental Protection Plan to anticipate and avoid impacts for approval by the Corps.
- Construction sequencing would avoid exposing the entire site at one time and would avoid having bare soils during rainy months.
- Construction methods would include stabilizing erodible surfaces with mulch, compost, seeding, or sod to avoid causing turbid runoff.
- Methods would include the use of isolation devices such as silt fences, gravel filter berms, silt dikes, check dams, and gravel bags for interception and dissipation of turbid runoff water to avoid contributing turbid water to a water body.
- Construction timing seasonally as well as diurnally can avoid exposure of fish, diving birds, and marine mammals to sound by scheduling the noise-inducing activities for times when the animals are less likely to be present.
- Marine mammal and marbled murrelet monitoring plans can be implemented in required to alert construction teams when the animals are nearby and work would stop until the animals leave.
- Impacts to agricultural resources will be avoided to the maximum extent practicable through project footprint adjustments or other measures as appropriate.
- All Hazardous, Toxic, and Radioactive Waste sites will be avoided.
- Impacts to wetlands would be avoided to the maximum extent practicable.
- The construction footprint would avoid impacts to essential fish habitat as established under the Magnuson-Stevens Sustainable Fisheries and Conservation Act.

b. Impact Minimization Measures. When avoidance is not feasible, the action agency should employ efforts to minimize impacts. The following is a list of methods to minimize adverse construction effects of the proposed restoration sites.

- Flag resources on site prior to construction to minimize the area of ground disturbance and vegetation clearing.
- Use the site's natural contours to minimize run-off and erosion.
- Encourage contractors to obtain construction materials and equipment from local producers or vendors to minimize energy use for shipping.
- Encourage construction personnel to carpool or use a crew shuttle van to minimize combustion of fuel and reduce emissions.
- Turn off equipment when not in use to reduce idling.

- Maintain equipment in good working order to maximize fuel efficiency and minimize emissions and to ensure no leaking or dripping occurs.
- All machinery that will work in or near water will be required to use vegetable-based products for its lubricants and other hydraulic fluids
- Sound-absorptive mats called sound aprons made of rubber, lead-filled fabric, or plastic layers can be hung around the noise source to help shield the aquatic environment from excessive noise if deemed necessary through site analysis during PED phase.
- Project features shall be designed to minimize post-project erosion of any identified areas of contaminated sediment that may occur downstream or downcurrent from the project footprint.
- Follow strict protocols for handling hazardous materials to minimize the risk of releases occurring.
- All bare soils, including sidecast material for topography improvements, will be hydroseeded or planted with native plants as early in the construction process as possible to minimize turbid runoff

c. Compensatory Mitigation Measures. Compensatory mitigation is not anticipated to be required since all of the ecosystem restoration activities authorized by this project have the purpose of resulting in net increases in aquatic resource area and functions.

Findings. The Corps has determined that all appropriate and practicable measures, including impact avoidance, minimization, and mitigation, will be taken to minimize potential harm to the aquatic ecosystem. There are no practicably available fill or discharge alternatives that would be environmentally preferable and still be consistent with engineering requirements while meeting the project need for disposition of dredged, fill, and sidecast material.

7. Other Factors in the Public Interest.

a. Fish and Wildlife. The Corps has coordinated with State and Federal agencies, as well as the Native American tribes of the Puget Sound basin, to assure careful consideration of fish and wildlife resources. The Corps will assure full compliance with the Endangered Species Act, Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, and all other applicable laws as described in Chapter 7 of the FR/EIS prior to project implementation. Project designs will be coordinated with all applicable natural resource agencies.

b. Water Quality. The Corps will obtain a Water Quality Certification under Section 401 of the Clean Water Act for each proposed action. The Corps will abide by the conditions in each 401 Water Quality Certification to ensure compliance with state water quality standards when conducting activities involving the discharge of dredged material into waters of the United States.

c. Historic and Cultural Resources. Based on cultural resources investigations, the Corps has determined that additional research and field investigations will be required during Pre-construction, Engineering, and Design phase (PED) to identify historic properties. Archaeological sites and other cultural resources have been identified within the area of

potential effect of the project. The Corps has coordinated with stakeholders to prepare a Programmatic Agreement for protection of cultural resources or mitigation for impacts to cultural resources (see Appendix D of the FR/EIS).

d. Activities Affecting Coastal Zones. The Corps has determined that this work is consistent to the maximum extent practicable with the enforceable policies of the State of Washington under the Coastal Zone Management Act. The Corps has prepared a Coastal Zone Management Act consistency determination for each site of the proposed action for review by the Washington Department of Ecology.

e. Environmental Benefits. The PSNERP is a set of ecosystem restoration sites along the Puget Sound nearshore zone. The types of features identified for restoration include freshwater and tidal wetlands, coastal embayments, intertidal mudflats, and estuarine tidal channels. The proposed restoration measures remove stressors such as bank stabilization, tidal barriers, wetland fill, overwater structures, and tidal channel restrictions including levees to allow natural processes to recover. The project would restore 2,101 acres of tidally influenced wetlands. This will restore the natural processes that support fish and wildlife and promote the ecosystem structures and functions provided by wetlands, kelp and eelgrass beds, and riparian vegetation. All three sites of the recommended plan include critical habitat for ESA-listed species.

f. Navigation. No disruption of navigation traffic is anticipated to result from the small bridge replacements as a component of restoration at the specific sites. The Corps would ask the U.S. Coast Guard to issue a Notice to Mariners before operations are initiated in the event that construction could disrupt navigation. The Corps will seek a Bridge Permit from the U.S. Coast Guard for replacement of the bridge at the Duckabush River.

Findings. The Corps has determined that the proposed action is within the public interest based on review of the public interest factors.

8. Conclusions. Based on the analyses presented in project NEPA and ESA documents, as well as the following 404(b)(1) Evaluation and General Policies for the Evaluation of Permit Applications analysis, the Corps finds that this project complies with the substantive elements of Section 404 of the Clean Water Act.

Clean Water Act Section 404(b)(1) Evaluation [40 CFR §230]

Potential Impacts on Physical and Chemical Characteristics (Subpart C)

1. Substrate [230.20] Substrate composition varies widely among the three proposed restoration sites. The purpose of the ecosystem restoration is to restore the natural hydrogeomorphological processes such that each site would evolve to host its most natural substrate characteristics and support bottom-dwelling organisms. Any imported materials would match native site conditions and would be free of contaminants.

2. Suspended Particulate/Turbidity [230.21] Discharge of excavated material will cause a temporary increase in turbidity and suspended particulate levels in the water column as tidal water or river flows inundate the restoration sites. Sand and silt sink rapidly to the bottom, while a small percentage of finer material is expected to remain in suspension for a period of several hours. Increases in turbidity associated with placement operations will be local (confined to the areas in the immediate vicinity of the active excavation and the placement sites during sediment placement) and of short duration (i.e., currents disperse any suspended material within hours of placement) (Simenstad 1988; Nightingale and Simenstad 2001). An excavator will be used on site where the Corps proposes to excavate distributary channels to accelerate site evolution for restoration purposes, remove levees and narrow and culverted bridges, and make room for bridge abutments and concrete piers. Work will be conducted in dry conditions to the maximum extent practicable. Isolation devices may be used during construction if work is necessary during wet conditions. Following construction, tidal inundation or river flows introduced to each site may initially become turbid, but immediately following construction, the water is expected to clear as disturbed sediments are redistributed through restored natural flows. In the case of pile installation for wide-span bridges, minimal disturbance of the substrate will occur during placement and may have temporary increase in turbidity and noise, but will have no permanent effect.

3. Water Quality [230.22] No significant water quality effects are anticipated. The types of fill or discharge that will occur for filling of ditches and drainage channels, bridge and culvert installations, and sidecasting of excavated material would not cause any significant or long-term degradation to color, odor, taste, or other chemical or physical characteristics aside from temporary turbidity as described above. As sites containing former agricultural fields are restored, this will reduce the type of nutrient input that can cause harmful algal blooms. Since placement operations will largely be conducted in dry conditions (or be isolated if conditions are wet) with an aquatic connection opened toward the end of the construction schedule in many cases, water quality impacts should be short lived (hours) and localized (immediate vicinity). Long-term benefits to water quality will occur through the restoration of 2,101 acres of wetlands, which serve as natural filters and help with sequestration of pollutants. Restoration will reconnect floodplains and riparian habitat.

4. Current Patterns and Water Circulation [230.23] The placement of fill and excavated materials will not obstruct flow; however, the purpose of the proposed restoration is to change the direction and velocity, and increase inundation area of water flow/circulation at each site, and to change the dimensions of the receiving water body at certain sites. The proposed action

is intended to achieve a net benefit to current patterns and circulation for improved water quality and aquatic organism habitat and productivity by restoring historic processes and functions of nearshore habitats.

5. **Normal Water Fluctuations [230.24]** The placement of fill and excavated material from the proposed restoration work will not impede normal tidal fluctuations; in fact, it will improve conditions at each restoration site.

6. **Salinity Gradients [230.25]** The placement of fill and excavated material is intended to improve tidal flows and may appreciably affect salt wedge or salinity gradients for the benefit of water quality and aquatic organism habitat and productivity.

Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D)

1. **Threatened and Endangered Species [230.30]** ESA consultation was completed via the Fish Passage and Restoration Project Biological Opinion. The Corps prepared a Biological Assessment for restoration projects. The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) issued the Biological Opinion for Fish Passage and Restoration Projects in Washington State to the Corps' Seattle District in 2008, and coverage under this Biological Opinion has been extended through 2018 by USFWS. The NMFS revised their consultation to specifically cover the actions proposed by the Nearshore Study. The reissuance of this consultation with explicit inclusion of all PSNERP sites and features occurred in January 2016. ESA-listed species are anticipated to see a net benefit as a result of this project.

2. **Aquatic Food Web [230.31]** Construction disturbance associated with fill may interfere with feeding and respiratory mechanisms of benthic, epibenthic, and planktonic invertebrates. Some sessile invertebrates in the aquatic areas of the sites will suffer mortality from construction disturbance. Potential impacts of material placement on salmonids, forage fish, and Dungeness crabs will be avoided through implementation of timing restrictions. The proposed restoration work is anticipated to provide a net benefit to the aquatic food web of Puget Sound. Details are provided in Chapter 5 of the FR/EIS.

3. **Wildlife [230.32]** Construction activity including pile driving, demolishing roads and culverted and narrow bridges, and hauling off large amounts of material would cause temporary disturbances to bird communities, terrestrial and marine mammals, and amphibians due to noise (both airborne and underwater) and the presence of heavy equipment. These disturbances would likely cause a behavioral response to flee the area. Best management practices, such as working outside of the nesting season, would minimize these impacts. At several sites, agricultural areas would be flooded due to removal of tidal barriers. These areas are seasonally heavily used by migratory bird species; allowing tidal flow to enter would likely lead to a transition from communities dominated by snow geese and trumpeter swans (which are not habitat-limited in the Puget Sound region) to a wider variety of species like goldeneye, sandpipers, wigeons, scaups, and brandts that are associated with salt water habitats. Freshwater marshes that would be flooded with brackish water would transition from species like mallards and pintails to the saltwater species mentioned previously. A variety of birds that depend on forage fish and juvenile and adult salmon would greatly benefit from restored sites

where these fishes' habitats (including marshes, eelgrass beds, and spawning beaches) are increased.

Marine mammals are likely to be present only at the Duckabush site during construction due to its proximity to the marine shoreline. The other two sites are farther upstream, making marine mammal presence unlikely. The primary impacts to marine mammals would result from noise disturbances caused by drilling machinery for the cast-in-place concrete piers, which could cause behavioral response such as fleeing, interfere with ability to locate prey, or result in physiological damage. Elevated turbidity could cause temporary displacement of marine mammals as well, likely those that occur in shallower water, such as harbor seals. Long-term benefits to marine mammals would be closely tied to the benefits provided to their prey, including increased habitat for forage fish and salmonids. Southern Resident killer whales would likely gain the most benefits from restoring processes that increase habitat for Chinook and chum salmon. Other marine mammals like porpoises, sea lions, and seals would benefit as well, but to a lesser extent since their diet consists of a wider variety of fish, some of which are not nearshore dependent. No impact hammer pile driving will occur at the restoration sites; therefore, disturbance from underwater noise is not anticipated to exceed regulated thresholds.

Potential Impacts to Special Aquatic Sites (Subpart E)

1. **Sanctuaries and Refuges [230.40]** The proposed action will not adversely affect any designated sanctuary or refuge area. Restoration will enhance the Skagit Wildlife Area (17,000 acres managed by Washington Department of Fish and Wildlife for hunting and wildlife viewing).
2. **Wetlands [230.41]** The project will overall have a net increase in total wetland area by restoring a total of 2,101 acres of various property types to become tidal or riverine wetlands. Some freshwater wetland areas may transition to more salt-tolerant plant and animal species. The Corps anticipates a net increase in functions and values of wetlands.
3. **Mudflats [230.42]** The project will overall have a net increase in total mudflat area supporting mudflat biota, and foraging and nursery areas.
4. **Vegetated Shallows [230.43]** The project will overall have a net increase in total area of vegetated shallows and will support nesting, spawning, nursery, cover, and forage areas.
5. **Coral Reefs [230.44]** Not applicable.
6. **Riffle and Pool Complexes [230.45]** Not applicable.

Potential Effects on Human Use Characteristics (Subpart F)

1. **Municipal and Private Water Supplies [230.50]** Not applicable.
2. **Recreational and Commercial Fisheries [230.51]** Removal of bank armoring, tidal barriers, and artificial fill in river deltas and embayments would provide more shallow water habitat for juvenile salmon migration, increase eelgrass beds that are critical nursery areas, and provide more spawning beaches for forage fish, an important prey item for salmon. The increased salmon habitat could be presumed to assist with recovery of diminished populations thereby adding potential for increased sportfishing. Benefits to multiple aspects of salmon ecology

would assist with recovery of this important recreationally and commercially harvested resource. Restoring important ecosystem processes of the nearshore zone could expand areas available for shellfish. Removal of tidal barriers would benefit clams, oysters, and crabs by increasing sediment delivery. Diversion of flow from the Nooksack River to the Lummi River will be optimized in PED phase so as not to impact shellfish beds in Bellingham Bay.

3. Water-Related Recreation [230.52] The proposed project would not significantly affect long-term public access. During construction activities, some access and recreation sites may be temporarily closed. Restoration of 2,101 acres of tidal wetlands would support fish and wildlife species and associated recreational opportunities such as bird watching opportunities. Finally, there is a chance for potential displacement or substitution of recreation opportunities associated with this alternative. Waterfowl hunting opportunities may be displaced by new or different recreation opportunities (e.g., bird watching) at some of the sites included in this alternative due to habitat type changing the type of birds that use the areas. One marina would be removed; this is Blake's Marina on the North Fork of the Skagit River. Recreational vessels would be expected to relocate to one of the several marinas within 10 miles. This project has no components that are specifically for recreational purposes.

4. Aesthetics [230.53] The proposed project sites would have a temporary reduction of aesthetic quality for the duration of construction, which may take months to years per site as vegetation matures. The long-term change, however, would be a return of the shoreline to a more natural configuration resembling the pre-settlement wilderness conditions. None of the stated values of the Shoreline Management Act would be precluded or degraded. The result of the proposed action would not degrade natural viewsheds, conflict with local guidelines or goals related to visual quality, reduce sunlight availability in residential areas, or obstruct views of valued resources. Therefore, the proposed action would have no significant impact on the visual quality and aesthetic resources in the Puget Sound area.

5. Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves [230.54] Ecosystem restoration of the Puget Sound Nearshore zone would have a net benefit to all valued qualities of parks, national and historic monuments, national seashores, wilderness areas, research sites and similar preserves.

Evaluation and Testing (Subpart G)

1. General Evaluation of Dredged or Fill Material [230.60] No specific soils testing has occurred at the project sites, but will be completed during PED phase. No contaminated material will be used as fill, nor will it be sidecast after excavation if found to contain contaminants. Sources of fill will be examined to ensure that any material imported to restoration sites to be used as fill will be clean material free of contaminants.

2. Chemical, Biological, and Physical Evaluation and Testing [230.61] No specific soils testing has occurred at the project sites, but will be completed during PED phase, or during construction phase prior to delivery to the restoration sites. Any material within the restoration sites found to contain contaminants will be permanently removed from the aquatic environment to an upland placement site.

Action to Minimize Adverse Effects (Subpart H)

1. Actions Concerning the Location of the Discharge [230.70] The effects of the discharge would be minimized by locating the fill to avoid smothering organisms. The construction timing will avoid periodic inundation patterns such as high tides, and project designs will restore natural patterns that have been interrupted. The location and timing of the discharge have been planned to minimize effects to marine organisms.

2. Actions Concerning the Material to be Discharged [230.71] No treatment substances nor chemical flocculates will be added to the materials before placement. Sidecast material and fill material will be placed on site in the smallest quantities required for restoration. Piles and bridge abutments for wide-span bridges will replace culverts and narrow roadway crossings to allow for unrestricted tidal flow.

3. Actions Controlling the Material after Discharge [230.72] Methods for reducing the potential for erosion, slumping, or leaching will be employed to minimize disturbance to the aquatic environment. The timing of placement will occur within environmentally protective work windows. The construction methods may employ berms and dewatering as necessary to control immediate runoff and associated loss of material deposited above the high tide line, but placed material is expected to subsequently erode through natural processes.

4. Actions Affecting the Method of Dispersion [230.73] The placement sites have been selected to execute process-based restoration and to avoid nearshore and wetland impacts from material placement. Some fill material will be used to plug drainage channels that have been inhibiting wetland development.

5. Actions Related to Technology [230.74] Appropriate machinery and methods of transport of the material for discharge will be employed. All machinery will be properly maintained and operated. Selection of machinery will be appropriate for each type of restoration site and will aim to avoid and minimize impacts to wetlands.

6. Actions Affecting Plant and Animal Populations [230.75] The timing of the proposed discharge operations will minimize the potential for adverse effects to animal populations. To avoid impacts to bull trout, juvenile salmon, and forage fish, the Corps will observe work windows and may use isolation devices if in-water work is necessary. Construction timing will avoid spawning and migration seasons and other biologically critical periods for fish and wildlife. Seasonality of plant life will be considered in both construction impacts as well as revegetation timing in restored sites.

7. Actions Affecting Human Use [230.76] The placement will not damage aesthetically pleasing features of the aquatic landscape. The placement will not increase incompatible human activity in remote fish and wildlife areas. Potential impacts on Native American fishing rights are minimized mainly by construction timing and close coordination with the potentially affected tribes. All public access available at the sites will be closed during construction but fully re-opened after construction is complete.

8. Other Actions [230.77] The Corps has considered the likely conversion of freshwater wetlands to estuarine and marine wetland ecosystem types. An alternatives analysis appears in the FR/EIS.

Application by Analogy of the General Policies for the Evaluation of Public Interest [33 CFR §320.4 for reference]

1. **Public Interest Review [320.4(a)]** The Corps finds these actions to be in compliance with the 404(b)(1) guidelines and not contrary to the public interest.
2. **Effects on Wetlands [320.4(b)]** Effects to wetlands have been determined to be a net benefit and will cause a net increase in wetland acreage.
3. **Fish and Wildlife [320.4(c)]** The Corps consulted USFWS and NMFS to ensure that direct and indirect loss and damage to fish and wildlife resources attributable to the proposed work will be minimized. The project will result in a net benefit to fish and wildlife resources.
4. **Water Quality [320.4(d)]** Timing of excavation and material placement will help reduce potential temporary local impacts on fish and wildlife due to water quality. The Corps will abide by the conditions of the Section 401 Water Quality Certification anticipated to be issued for each restoration site to ensure compliance with water quality standards when conducting activities involving the discharge of dredged material into waters of the United States.
5. **Historic, Cultural, Scenic, and Recreational Values [320.4(e)]** No wild and scenic rivers, National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreation Areas, National Lakeshores, National Parks, National Monuments, or estuarine and marine sanctuaries will be adversely affected by the proposed work. Some historic properties and archaeological resources have been identified at the project sites. The Corps is consulting with the State Historic Preservation Office and the Advisory Council on Historic Preservation regarding the agency's Section 106 responsibilities. See Appendix D of the FR/EIS.
6. **Effects on Limits of the Territorial Sea [320.4(f)]** The proposed work will not alter the coastline or baseline from which the territorial sea is measured for the purposes of the Submerged Lands Act and international law.
7. **Consideration of Property Ownership [320.4(g)]** Projects will not be implemented without obtaining all applicable lands, easements, and rights-of-way. Section 6.5 of the FR/EIS outlines the real estate planning strategy.
8. **Activities Affecting Coastal Zones [320.4(h)]** The proposed action is consistent to the maximum extent practicable with the policies, general conditions, and general activities specified in the Washington State Coastal Zone Management Program. Individual Coastal Zone Consistency Determinations have been prepared for each project according to its locality.
9. **Activities in Marine Sanctuaries [320.4(i)]** The proposed action will not affect any marine sanctuaries.
10. **Other Federal, State, or Local Requirements [320.4(j)]** The Corps has analyzed the proposed action under all applicable Federal, State, and local requirements and documented this compliance in Chapter 7 and Appendix J of the FR/EIS.
11. **Safety of Impoundment Structures [320.4(k)]** Not applicable.
12. **Floodplain Management [320.4(l)]** The proposed work will restore and improve floodplain areas.
13. **Water Supply and Conservation [320.4(m)]** Not applicable.
14. **Energy Conservation and Development [320.4(n)]** Not applicable.

15. Navigation [320.4(o)] No permanent impacts to navigation are anticipated. Diversion of flow from the Nooksack River to the Lummi River will be optimized in PED phase so as not to impact navigation on the Nooksack River.

16. Environmental Benefits [320.4(p)] The three sites of the recommended plan will restore 2,101 acres of tidally influenced wetlands or beach area.

17. Economics [320.4(q)] Restoration of natural resources is anticipated to have a net benefit to socioeconomic resources through increasing populations of recreationally and commercially harvested species.

18. Mitigation [320.49(r)] Project designs will incorporate all available impact avoidance and minimization measures to the extent practicable. Compensatory mitigation is not anticipated to be required since all of the ecosystem restoration activities authorized by this project have the purpose of resulting in net increases in aquatic resource functions.

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January 8, 2016

U.S. Army Corps of Engineers
Seattle District
ATTN: Mr. Evan R. Lewis, Chief
Environmental and Cultural Resources Branch
P.O. Box 3755
Seattle, Washington, 98124-3755

Re: Puget Sound Nearshore Ecosystem Restoration Project

Dear Mr. Lewis:

The State of Washington Department of Ecology (Ecology) appreciates the early coordination efforts by the U.S. Army Corps of Engineers (Corps) concerning the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). Ecology has received documentation of compliance with Clean Water Act Section 404(b)(1) and preliminary information regarding Coastal Zone Management (CZM) Federal Consistency Determination for the following sites listed in the Recommended Plan for PSNERP:

1. Nooksack River Delta, Ferndale, WA.
2. North Fork Skagit River Delta, La Conner, WA
3. Duckabush River Estuary, Jefferson County, WA

Ecology appreciates the opportunity to review the project proposal and supports the continued development of the proposed projects and plans. These ecosystem restoration projects offer the opportunity to provide meaningful improvements to water quality while also improving marine and estuarine habitat in Puget Sound, an estuary of national significance.

Based upon the review of the proposed project during the feasibility phase and additional information, Ecology is optimistic that the Corps will be able to design the projects with necessary measures for the protection of water quality. Also because of the ongoing coordination between the Corps and Ecology the Corps should be able to provide the necessary documentation to move through the Section 401 Water Quality

Certification (WQC) request and CZM consistency review processes prior to construction.

Ecology is providing this letter of support to the Corps to continue to seek funding for these important projects. Please be advised that this letter does not substitute for or prejudge Ecology's Section 401 Water Quality Certification and CZM consistency decisions which will be issued in the future.

We look forward to continuing coordination on these proposals as you move into the formal permit phase. Please contact Loree' Randall at 360/407-6068 if you have any questions.

Sincerely,

Brenden McFarland
Shorelands & Environmental Assistance Program
Headquarters Office – Ecology
State of Washington

cc: Loree' Randall, Ecology

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

FEB 4 2010

Colonel Anthony Wright
Seattle District Commander
U.S. Army Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124

Dear Colonel Wright:

Subject: Puget Sound Nearshore Ecosystem Restoration Project

On behalf of the U.S. Fish and Wildlife Service (Service), I am writing to define our agency's position of support for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) General Investigation. It is our intent that this agency view letter be included in the feasibility scoping meeting submittal package currently being prepared by your staff for transmittal to U.S. Army Corps of Engineers Headquarters. Our agency has consistently supported the work of PSNERP to systematically assess nearshore conditions in Puget Sound, use sound science to identify and advance priority restoration and protection actions, and increase funding for nearshore project implementation; all towards advancing our shared goal of the recovery of Puget Sound.

Our on-going support for PSNERP is directly related to advancing our agency mission and objectives. The mission of the Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The Service also helps ensure a healthy environment for people through its work benefiting wildlife, and by providing opportunities for Americans to enjoy the outdoors and our shared natural heritage. In carrying out our duties, we understand the need for a strong reliance on science, and the importance of working collaboratively with other agencies and organizations. The PSNERP has consistently applied these strategies to achieve success.

The Service has provided in-kind support to PSNERP through participation of our staff in all aspects of PSNERP. The Service is represented on PSNERP Executive and Steering Committees. Our technical staff have been active participants in the Nearshore Science Team and Implementation Team, providing their experience and expertise in coastal ecosystem restoration, monitoring, and project evaluation. For over five years, Service biologist Curtis Tanner has been on assignment to the Washington Department of Fish and Wildlife, serving as the PSNERP local project manager. His technical expertise has benefitted the project's science basis, and he has helped integrate the lessons of PSNERP into our agency's work.

TAKE PRIDE® IN AMERICA

The Service has already used emerging results from PSNERP in successfully implementing on-going restoration programs, including the Puget Sound Coastal Program. The PSNERP's comprehensive, Sound-wide analysis of change in nearshore ecosystem conditions and additional site specific information is valuable for our understanding of what has been lost in Puget Sound. This information will help us to define priorities and strategic approaches for the future. Having access to this level of information and sharing it with our partners will result in more effective and strategic restoration and protection actions.

Early actions identified through the Estuary and Salmon Restoration Program, associated with PSNERP, have provided opportunities for the Service to cost-share on regional priorities. Coastal Program funds and staff time have been used to help achieve on the ground benefits from PSNERP early actions. Similarly, the Estuary and Salmon Restoration Program's investment in estuary restoration at Nisqually National Wildlife Refuge, and PSNERP technical support for monitoring plan development, has provided a mutually beneficial partnership advancing the goals of the Service.

The approach used by the PSNERP study team provides a successful example for science-based decision support for ecosystem management. The Service will use the lessons and results from PSNERP as we advance Landscape Conservation Cooperatives (LCCs). We expect that stressors, threats, and conservation opportunities identified by PSNERP will help inform the North Pacific LCC. The LCCs are conservation-science partnerships between the Service, U.S. Geological Survey, and other agencies, states, tribes, and stakeholders within an ecoregion. They inform resource management decisions to address landscape-scale stressors which are anticipated to be accelerated by climate change.

Finally, the Service understands and supports the important contribution that PSNERP is making, and will continue to make, to the Puget Sound Partnership (Partnership). Identified as an Action Agenda priority, PSNERP delivers the nearshore component of the Partnership's efforts to recover the health of Puget Sound. The Service is an active member of the Puget Sound Federal Caucus and the Ecosystem Coordination Board, and strongly supports the role the PSNERP serves in meeting the Partnership's objectives.

Thank you for the opportunity to express our agency view. If you have any questions, or require additional information on the work of the Service in Puget Sound, please contact Mary Mahaffy at (360-753-7763).

Sincerely,

Ken S. Berg

Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc:
COE, Seattle, WA (B Hargrave)

From: Jensen, Martha
To: Baird, Maryann NWS; Lewis, Evan R NWS
Cc: Gleason, Nancy C NWS; Laufle, Jeffrey C NWS; Jackels, Chemine R NWS; Urelius, Karen M NWS; Shirley Burgdorf
Subject: [EXTERNAL] Re: FPRP - request for approval on 1 restoration project
Date: Thursday, February 04, 2016 9:52:41 AM
Attachments: Duckabush River Estuary Restoration Approval.doc
SkagitDelta_Restoration_EmailApproval.docx
Nooksack_Restoration_EmailApproval.docx

Evan and Maryann

This is in response to your November 13, 2015 letter requesting review of Specific Project Information Forms for restoration actions in the Duckabush River, Nooksack and Lummi Rivers, and the North Fork of the Skagit River as part of the Puget Sound Nearshore Ecosystem Restoration Projects (PSNERP). The Corps requested approval for use of the 2008 Fish Passage and Habitat Restoration Programmatic for consultation for these three projects pursuant to Section 7 of the Endangered Species Act.

In September, 2013, the Service reviewed projects that were covered under the 2008 Fish Passage and Habitat Restoration Programmatic (Ref.# 13410-2008-F-0209) during the first five years and determined that the programmatic could be extended because: 1) the environmental baseline previously analyzed remains relatively unchanged; 2) effects of activities analyzed and addressed in the Opinion would be the same; 3) the incidental take that was exempted under the Opinion has not been exceeded and is not expected to be reached due to the extension; 4) allowing restoration projects to continue will not jeopardize the continued existence of of listed species under our jurisdiction. On May 29, 2012, the National Marine Fisheries Service and U.S. Fish and Wildlife Service provided a letter of support to the Corps to cover PSNERP under the Corps Programmatic.

The electronic approvals for these projects are attached. If you have any questions, please feel free to contact me.

Martha Jensen
Branch Manager, Federal Activities
Division of Consultation and Conservation Planning
Washington Fish and Wildlife Office
510 Desmond Dr. SE
Lacey, Washington 98503
tel: (360) 753-9000 fax: (360) 753-9008
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On Fri, Nov 13, 2015 at 9:09 AM, Baird, Maryann NWS <Maryann.Baird@usace.army.mil <mailto:Maryann.Baird@usace.army.mil> > wrote:

Hi Martha -

Today we'll be sending by postal service our request for approval on 1 project under the 2008 Fish Passage and Restoration programmatic consultation (PC). Our letter requesting consultation is attached.

JEFFERSON, WHATCOM, AND SKAGIT CO - FWFS ONLY

1) U.S. Army Corps of Engineers, a project proposing restoration actions in the Duckabush River (Jefferson County), Nooksack River (Whatcom County), and North Fork Skagit and Lummi Rivers (Skagit County). These actions, which we discussed via teleconference in October, are associated with the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). The actions meet all conditions of the PC. NOTE: Because the NMFS' biological opinion with the Corps for the FPRP PC expired, the Corps is requesting individual consultation with NMFS.

Please send your approval for the action to me, Nancy Gleason, Jeff Laufle, and Karen Urelius. We look forward to receiving your approval.

Maryann Baird
Endangered Species Act Coordinator
Regulatory Branch, Seattle District
US Army Corps of Engineers
Post Office Box 3755
Seattle, Washington 98124-3755
Telephone: 206.764.5531
Email: Maryann.Baird@usace.army.mil <mailto:Maryann.Baird@usace.army.mil>

Electronic Approval for Use of the
2008 Fish Passage and Restoration Programmatic

U.S. Army Corps of Engineers Civil Works Duckabush River Delta Restoration Project
(FWS# 01EWFW00-2016-TA-0168, xref: 13410-2008-F-0209)

The U.S. Fish and Wildlife Service (Service) has reviewed the Specific Project Information Form (SPIF), dated November 18, 2015, for restoration projects in the Duckabush River Estuary. The U.S. Army Corps of Engineers – Seattle District Civil Works Department (Corps) made a "may affect, not likely to adversely affect" determination for the marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and designated critical habitat for the bull trout (*Salvelinus confluentus*) and a "may affect, likely to adversely affect" determination for the bull trout associated with the Duckabush restoration projects. There is no suitable spotted owl or marbled murrelet nesting habitat within one mile of the project site and the proposed action will not result in noise levels that could extend into potential nesting habitat. The project does not include pile driving or blasting and all construction activities are far enough inland (approx. 0.3 miles away from open marine water) that we do not expect disturbance to marbled murrelets that may be foraging in Hood Canal.

The Corps, in conjunction with tribes, state agencies and partners, proposes to fund restoration projects in the Duckabush Estuary to improve hydrologic connectivity and restore intertidal habitat in the delta. The Duckabush watershed is located on the eastern side of the Olympic Peninsula and drains into Hood Canal just south of the community of Brinnon, Jefferson County, Washington. Currently, U.S. Route 101 is built on fill material and cuts directly across the river delta, severely impacting tidal flows and estuary functions. The mainstem Duckabush River and distributary channels are directed through two undersized culverts which severely constrict flows, sediment transport and morphology. To improve and restore estuary processes, the Corps is proposing to relocate the highway landward and replace the culverts with a new elevated full channel-spanning bridge. The new bridge will allow the river and its distributary channels to reconnect and flow unimpeded into Hood Canal. The project includes installation of woody debris, removal of fill material and culverts, and planting disturbed areas with native species. Reconnection of the north distributary channel will improve tidal processes and allow fresh water to more efficiently transport and deliver sediments and bedload materials.

Relocating the highway will require installation of cofferdams or caissons and worksite isolation (including fish removal) where new bridge footings and piers will be located, installation of temporary crossing structures, and a temporary work trestle. New footings will be drilled into the substrate material and temporary structures will be removed after the project is completed. All work below the ordinary high water mark will be conducted during the approved work window (July 16 through August 31). Removal of culverts, fill material, and piles from existing crossing structures will require sediment management (worksite isolation) to reduce impacts to water quality. Other in-water work associated

with dike breaching and channel rehabilitation will be sequenced and timed during the summer low flows to minimize impacts to listed fish. The project does not include impact pile driving or blasting; all support structures will be drilled in. The project is expected to take 2 to 3 years to complete and will result in the restoration of approximately 38 acres of freshwater and estuary habitat at the mouth of the Duckabush River.

There are only two documented occurrences of bull trout in the Duckabush River (from 1992) and only a few historical records of isolated observations in other drainages in western Hood Canal. The project site is located more than 20 miles north of the nearest bull trout population in the Skokomish River. The population in the Skokomish River is fluvial and adfluvial (above Cushman Dam). As there are no documented occurrences of individuals from the Skokomish River entering the estuary or marine waters, it is presumed that the anadromous life history form is severely depressed, extirpated, or absent.

The western shoreline of Hood Canal is designated critical habitat for bull trout. The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The proposed activities will impact several of the primary constituent elements (PCEs) of critical habitat, including the following: the migratory corridor (PCE 2), prey base (PCE 3), nearshore habitat complexity (PCE 4), the natural hydrograph (PCE 7), and water quality (PCEs 5 and 8).

PCE 2 - Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers. The proposed action will result in temporary impacts to water quality and disturbance associated with elevated levels of turbidity and suspended sediments. Removing levees and berms supporting the road, bridge and culverts, realigning distributary channels, and installing large wood will produce pulses of increased turbidity during and after construction at each high tide and during the first heavy rain events after the cofferdams have been removed. Increased turbidity will be short-term and will not preclude bull trout from being able to move through the area during or after construction. Long-term effects of the proposed action are expected to be beneficial because replacing the berms and constricting bridge and culverts with larger, elevated crossing structures, will improve flows and the overall function of the migratory corridor. Therefore, short- and long-term effects to the migratory corridor are considered insignificant and beneficial, respectively.

PCE 3 - An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish. The proposed action may impact the food base through short-term degradation of water quality and disturbance of intertidal habitat during construction. Upon completion of the proposed action, we anticipate that the newly restored estuary, tidal channels and tidal marshes, will provide habitat for juvenile salmonids, marine forage fish, and a diversity of terrestrial and marine invertebrates. The

installation of large wood complexes and removal of levees will improve both habitat complexity and the food base in the action area and is expected to increase the abundance and diversity of aquatic macroinvertebrates and juvenile fish, both of which are prey for bull trout. Therefore, long-term effects to this PCE are considered beneficial.

PCE 4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
The proposed action is designed to improve instream and wetland habitat complexity and restore connectivity of the Duckabush River and tidal channels in the estuary at the confluence with Hood Canal. The project will improve hydrologic flows (freshwater discharge and tidal mixing) and estuary processes, restore saltmarsh habitats and instream complexity, and increase tidal channel diversity in the estuary. Removal of the levees and reconnection of distributary channels will improve floodplain connectivity, restore interception of groundwater sources and hyphoreic flows, and provide better mixing of fresh and saltwater. Opening the constrictions will also improve the transport and deposition of trees and logs that are carried down by the current; the placement of large wood will serve to capture debris and restore instream habitat complexity until the system reaches equilibrium and natural estuary processes have been restored. Overall, long-term effects of the action on this PCE are considered beneficial.

PCE 7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph. The proposed action will remove the current channel constrictions and greatly improve flows. Elevating and reconfiguring the bridge and removing undersized culverts will allow high flows to move unimpeded, reconnect the river to historic side and distributary channels in the estuary, improve natural tidal flushing, and restore the hydrograph back to near-historic/natural conditions in the lower Duckabush River. The installation of large wood will create scour pools; restoration of tidal channels will provide slow water areas and reduce the velocity of peak flows; and removal and widening of channel constrictions will improve discharge of freshwater and reduce backflow and reflux of marine water during high tides. Because the project will improve the natural hydrology, ecological processes, and natural channel complexity of the river and estuary, long-term effects to this PCE are considered beneficial.

PCE 8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited. Although there may be short-term and localized elevated turbidity associated with the removal of berms and culverts, installation of temporary crossing structures and the placement of large wood, most of the work will be conducted in the dry (inside cofferdams and silt screens) and will not result in adverse effects to water quality during construction. However, once the cofferdams are removed and disturbed areas are inundated by high tides and/or high flows, sediments in disturbed areas will be resuspended. Impacts to water quality will be episodic and relatively short (weeks or months) in duration as sediments are redistributed across the estuary and mixed with marine waters. Pulses of turbidity likely will continue until the restored tidal

channels and disturbed sites reach equilibrium (most likely after the first winter). Because the project site is located at the confluence of the marine environment in a location where background levels of turbidity are relatively high, these periodic increases in turbidity are not expected to affect normal reproduction, growth or survival of bull trout or other salmonids in the project area. Short-term effects to water quality may be measurable, especially during high tides or storm events the first winter after construction. Once the restoration site stabilizes, impacts to water quality are expected to improve over current condition due to improved flow conditions.

As per the criteria set forth in this programmatic consultation, the Service is responding via this electronic format to give approval to cover the proposed action under the programmatic. The project complies with the conservation measures outlined for the following Activity Categories: 1. Fish Passage (replacement of culverts and bridges); 2. Instream Structures (installation of large wood and engineered log jams); 3. Levee Removal and Modification; and 4. Side or off-Channel Habitat Restoration and Reconnection. The consultation tracking number for this action is 01EWFW00-2016-TA-0168 (xRef.: 13410-2008-F-0209).

Incidental Take Statement

The Service expects very few, if any, bull trout to be present in the Duckabush River when construction is scheduled to begin. The project is fairly large, with construction activities extending over three years and the potential for periodic elevated levels of turbidity extending through the winter following each construction season. Adult and larger subadult bull trout are highly mobile and can easily detect and avoid inwater activities and areas of high turbidity. Because of the distance to the nearest core area, no juvenile bull trout will be affected, and we do not anticipate any adult or larger subadult bull trout to be physically injured or killed during project implementation. Since most of the excavation work and bridge construction will be conducted behind cofferdams, during the time of year when bull trout are less likely to be in the marine environment, and the project is located more than 20 miles from the nearest population, the likelihood of bull trout being exposed to project activities or degraded water quality is extremely low.

Based on the available information, the Service is exempting incidental take in the form harassment (disturbance) of one adult bull trout associated with exposure to fish exclusion efforts and elevated levels of turbidity. The duration of potential effects will extend from mid-July through December each of the three years that construction will be conducted. These effects will extend from the culvert crossing on Shorewood Road (approximately 900 ft upstream of the northern bridge crossing) to the edge of the delta fan, approximately 5,000 ft downstream of Shorewood road and all areas in between where tidal channels will be restored, wood will be installed and construction activities will occur. The Fifth Field HUC Code for this project is 1711001804 (Duckabush River).

The Corps has met their obligation under Section 7 of the Endangered Species Act and no further consultation on this action is required unless the project changes. Standard reinitiation triggers for consultation apply if: 1) new information reveals effects of the

action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, 3) a new species is listed or critical habitat is designated that may be affected by this project, and/or 4) the amount of incidental take exempted for the projects is exceeded. Project progress reports on in-water work and results of fish capture and handling efforts should be sent to:

Eric V. Rickerson, State Supervisor
(Attn. Martha Jensen or Shirley Burgdorf)
Washington Fish and Wildlife Office
510 Desmond Drive SE
Lacey, Washington 98503

The U.S. Fish and Wildlife Service tracking number for this project is 01EWFW00-2016-TA-0168. If you have any questions, please contact me at (360) 753-9000 or send an e-mail to Martha_1_jensen@fws.gov

Thank you

Electronic Approval for use of the
2008 Fish Passage and Restoration Programmatic

U.S. Army Corps of Engineers Civil Works Nooksack and Lummi Rivers Restoration Project
(FWS# 01EWFW00-2016-TA-0203, xRef: 13410-2008-F-0209)

On November 18, 2015, the U.S. Fish and Wildlife Service (Service) received your letter, the Memorandum for the Services, and Specific Project Information Form requesting consultation for the U.S. Army Corps of Engineers –Seattle District Civil Works Nooksack River Delta Restoration Project. The U.S. Army Corps of Engineers (Corps) made a "likely to adversely affect" determination for the bull trout (*Salvelinus confluentus*) and a "may affect, not likely to adversely affect" determination for the marbled murrelet (*Brachyramphus marmoratus*) and designated bull trout critical habitat. The project is located near the town of Ferndale, in Whatcom County, Washington (T39N, R2E, Sections 31 and 32 and several in T38N, R02E, Sections 5, 6, 8, and 17). There is no suitable marbled murrelet nesting habitat within one mile of the project site and the proposed action will not result in noise levels that could extend into potential nesting habitat.

The proposed project includes: 1) levee removals, breaches, and setbacks; 2) installation of three engineered log jams (ELJs); 3) hydraulic modifications (diversion at Lummi River connection with the Nooksack River); 4) channel creation and rehabilitation, 5) property acquisition; 6) removal or alteration of existing bridges; 7) installation of new bridges and other traffic structures; and 8) planting riparian vegetation. Installation of caissons and/or cofferdams will be used where bridge piers and ELJs would be located in water, and diversion and/or isolation of work areas will comply with the protocols established in the 2008 Fish Passage and Restoration Programmatic. Any fish stranded due to work area isolation and dewatering will be removed using dip nets, seines, and electrofishing (if necessary). Most of the construction activities will be accomplished using land-based heavy equipment. Some temporary stream crossings may be necessary. Temporary trestle structures and/or local filling may be needed along the proposed bridge alignments to provide access for heavy equipment. The trestles and fill will be removed at the end of construction. Turbidity monitoring will occur during all in-water work and will comply with the conditions issued in the water quality certification issued by the Washington Department of Ecology. Construction of each bridge will take 10 to 18 months, and the entire project is expected to take two to four years. In-water work will be sequenced and timed during the summer in-water work window to minimize turbidity and other disturbance. Work site isolation will require fish exclusion, capture and handling.

If changes are proposed during the pre-construction engineering and design phase, the Service will be contacted to determine if reinitiation of consultation is necessary. The standard reinitiation triggers for consultation are: 1) new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) the action is modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, 3) a new species is listed or critical

habitat is designated that may be affected by this project, and/or 4) the amount of incidental take exempted for the projects is exceeded.

Best management practices will be used during all construction activities. Turbidity monitoring will occur during all in-water work and will comply with the conditions issued in the water quality certification issued by the Washington Department of Ecology. The purpose of the project is to restore the natural hydraulic, sediment, and ecological processes to the action area in the lower Nooksack River.

The project is located in the Nooksack and Lummi Rivers just upstream of the rivers' deltas. The Nooksack River watershed is a core area for bull trout (local populations and spawning and rearing). Bull trout in the Nooksack are fluvial or anadromous and have been documented using freshwater floodplain areas along the mainstem Nooksack River, tributaries and side channels, as well as nearshore marine areas north and south of the Lummi Peninsula. Based on telemetry studies in other similar bull trout systems (Skagit and Snohomish Rivers), juvenile bull trout in the Nooksack River move downstream from their natal areas at age 2 and individuals as small as about 90 mm (fork length) may be present in the lower river. Many subadult and adult bull trout make extensive use of the lower rivers and nearshore marine areas for extended rearing, foraging, and/or overwintering.

It is thought that the Nooksack core area supports a spawning population of migratory bull trout that numbers less than 1,000 adults. The nearest potential bull trout spawning habitat is found in the upper watershed. Although non-reproductive adult, subadult, and larger juvenile bull trout may be present in the action area, few bull trout are expected to be present during the in-water work window (July 16 to August 15). Because of the level of temporary increased turbidity from in-water construction activities, the Service anticipates disturbance (significant impairment of normal behavior) of adult, subadult, and juvenile bull trout that may be present within the proposed project area. We also expect dewatering and fish handling (seining, capture, electrofishing) of individual fish to result in significant disturbance and stress or even injury and death.

The project reach is designated as critical habitat. The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The following PCEs are present in the action area and may be affected by the proposed action:

PCE 1 - Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia. The proposed action is designed to improve complexity and connectivity to the floodplain of the Nooksack River. Setting back levees will result in more available floodplain area, increase interception of groundwater sources and improve hyphoreic connections. The installation of ELJs will create deep pool habitat and cold water refugia. Thus, the long-term effects of the action on this PCE are considered beneficial.

PCE 2 -Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats,

including but not limited to permanent, partial, intermittent, or seasonal barriers. The proposed action will result in temporary impacts to water quality and disturbance associated with elevated levels of turbidity and suspended sediments. Construction of the setback levees, breaching of the existing levees, and installation of large woody debris will produce pulses of increased turbidity especially during the first heavy rains and high water. Increased turbidity will be short-term and will not preclude bull trout movement through the area during and after construction. Long-term effects of the proposed action are expected to be beneficial because the lowering and breaching of the existing levees and the installation of ELJs will provide foraging habitat and complexity. Therefore, construction-related effects to this PCE are considered insignificant and long-term effects are anticipated to be beneficial.

PCE 3 - An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish. The proposed action may affect the food base of bull trout through short-term degradation of water quality. Upon completion of the proposed action, we anticipate that the newly planted riparian vegetation will, in one to five years, grow to provide some shade, macroinvertebrates, and other organic inputs. The river reach provides habitat for juvenile salmonids and a diversity of aquatic macro-invertebrates. The installation of ELJs, removal of levees, and channel restoration will improve both habitat complexity and the food base in the action area and is expected to increase the abundance and diversity of aquatic macroinvertebrates and juvenile fish, both of which are prey for bull trout. Therefore, long-term effects to this PCE are considered beneficial.

PCE 4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure. The primary objective of the project is to restore stream and floodplain functions and increase habitat and channel complexity in the action area through the restoration of floodplain connectivity, channel creation and rehabilitation, installation of ELJs, and riparian vegetation plantings. No measurable short- or long-term construction-related impacts to this PCE are anticipated. Therefore, effects to this PCE are considered beneficial.

PCE 7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph. The proposed action will create new floodplain connectivity in the newly accessible areas due to levee setbacks. Increasing floodplain connectivity and enlarging channel constrictions (e.g. replacing constrictions with wider span bridges) will improve flows and improve natural flushing and tidal inundation in the lower river. Because the proposed project will improve the natural hydrology, ecological processes, and natural channel complexity of the river, long-term effects to this PCE are considered beneficial.

PCE 8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited. Although there may be short-term and localized elevated turbidity associated with the removal of berms and culverts, installation of temporary crossing structures and the placement of large wood, most of the work will be conducted in the dry (inside cofferdams and silt screens) and will not result in adverse effects to water quality during

construction. However, once the cofferdams are removed and disturbed areas are inundated by high tides and/or high flows, sediments in disturbed areas will be resuspended. Impacts to water quality will be episodic and relatively short (weeks or months) in duration as sediments are redistributed across the estuary and mixed with marine waters. Pulses of turbidity likely will continue until the restored tidal channels and disturbed sites reach equilibrium (most likely after the first winter). Because the project site is located at the confluence of the marine environment in a location where background levels of turbidity are relatively high, these periodic increases in turbidity are not expected to affect normal reproduction, growth or survival of bull trout or other salmonids in the project area. Short-term effects to water quality may be measurable, especially during high tides or storm events the first winter after construction. Once the restoration site stabilizes, impacts to water quality are expected to improve over current condition due to improved flow conditions.

Incidental Take Statement

Given the duration of in-water work (two to four in-water work seasons), the Service anticipates individual bull trout that are in the project area to be exposed to elevated levels of turbidity and to disturbance associated with access crossings, installation of the ELJs, bridge construction, and breaching of the levees. We also expect dewatering and fish handling (seining, capture, electrofishing) of individual fish to result in significant disturbance and stress, injury or potential mortality.

Most of the adult bull trout will be upstream of the project reach in their natal streams preparing to spawn at the time that in-water work will be conducted. Some non-reproductive adults, subadults, and larger juvenile bull trout may be present in the action area; however, we expect the number of fish that may be present and exposed to construction to be small, due to the time of year that work will be done (summer low flow) and the low bull trout population in the watershed.

Adverse effects to large juvenile, subadult, and some non-reproductive adult bull trout are anticipated from activities that generate high levels of turbidity and disturbance associated with use of heavy equipment, installation of ELJs, channel rehabilitation, levee removal, work site isolation, and fish handling. In-water work is scheduled to occur between July 16 and August 15 over two to four consecutive years. All adult, subadult, and larger juvenile bull trout that are present in the project reach and area of elevated turbidity will experience significant impairment of feeding, sheltering, and normal behavior (harassment) during installation of the ELJs. A small number of adult, subadult, and larger juvenile bull trout in the project area may be physically injured or killed (harmed) during work site isolation, dewatering and fish handling efforts.

The extent of take in the action area will extend for approximately 100 ft upstream and up to 1,000 ft downstream of each in-water construction activity. In-water activities will occur at approximately ten sites including installation of three ELJ, reconnection of the Lummi River, grading and rehabilitation of existing Lummi River channels, and installation of five new bridges. All individuals that are present in areas where elevated turbidity and suspended sediments occur will be exposed to stress and/or potential disturbance. The duration of take is intermittent between July 16 and August 15 and during high flow events in the winter following

construction over two to four in-water work seasons. Project progress reports on in-water work and results of fish capture and handling efforts should be sent to:

Eric V. Rickerson, State Supervisor
(Attn. Martha Jensen or Shirley Burgdorf)
Washington Fish and Wildlife Office
510 Desmond Drive SE
Lacey, Washington 98503

The proposed action meets all of the applicable criteria in the Fish Passage and Habitat Enhancement Restoration Programmatic (Programmatic) for Activity Category 2: Installation of Instream Structures, Category 3: Levee Removal and Modification, 4: Side Channel/Off Channel Habitat Restoration and Reconnection; and Category 11: Ecosystem Function Improvements. As per the criteria set forth in the Programmatic, the Service is responding via this electronic format to give approval to cover the proposed action under the Programmatic. The Fifth Field HUC Code for this project is 1711000405 (Nooksack River).

Unless there are significant changes, the Corps has met their obligation under Section 7 of the Endangered Species Act and no further consultation on this action is required. The U.S. Fish and Wildlife Service tracking number for this project is 01EWFW00-2016-TA-0203. If you have any questions, please contact Shirley Burgdorf at (360) 534-9340 or Martha Jensen at (360) 753-9000, of this office.

Thank you

Electronic Approval for use of the
2008 Fish Passage and Restoration Programmatic

U.S. Army Corps of Engineers Civil Works Skagit River Delta Restoration Project
(FWS# 01EWFW00-2016-TA-0204, xref: 13410-2008-F-0209)

On November 18, 2015, the U.S. Fish and Wildlife Service (Service) received your letter, the Memorandum for the Services, and Specific Project Information Form requesting consultation for the U.S. Army Corps of Engineers –Seattle District Civil Works Skagit River Delta Restoration Project. The U.S. Army Corps of Engineers (Corps) made a "likely to adversely affect" determination for the bull trout (*Salvelinus confluentus*) and a "may affect, not likely to adversely affect" determination for the marbled murrelet (*Brachyramphus marmoratus*) and designated bull trout critical habitat. The project is located near the town of Mount Vernon, in Skagit County, Washington (T33N, R3E, Section 9). There is no suitable marbled murrelet nesting habitat within one mile of the project site and the proposed action will not result in noise levels that could extend into potential nesting habitat.

The proposed project includes: 1) lowering and of breaching levees, 2) constructing new levees landward of the existing levees, 3) excavating distributary channel networks, 4) removing shoreline armor, buildings, pavement, a boat ramp, and roads from the floodplain, and 5) planting riparian vegetation on sidecast berms created during levee lowering and along the new levees. Access to the work sites will be by existing county and farm access roads. In-water work will be sequenced and timed during the approved in-water work window (June 15 through August 31) to minimize turbidity and impacts to listed fish. Some limited earthwork from in-water barges may be needed to remove armoring and isolation of work area during in-water work may be necessary. Use of these activities will be determined during the pre-construction engineering and design phase. If changes are proposed, the Service will be contacted to determine if reinitiation of consultation is necessary. Best management practices will be used during all construction activities. Turbidity monitoring will occur during all in-water work and will comply with the conditions issued in the water quality certification issued by the Washington Department of Ecology. The pre-construction engineering and design phase will be developed over one to two years, and the proposed construction activities will take one to two years to complete. The purpose of the project is to restore the natural hydraulic, sediment, and ecological processes on 256 acres of floodplain along the lower 2 miles of the North Fork Skagit River downstream of Best Road and north of Rawlins Road. The project should be designed to prevent or reduce the risk of fish becoming stranded inside constructed channels or behind levees and to ensure that there are adequate flows to flush and maintain distributary channels, thus minimizing the need for maintenance or repairs in the future.

The project is located at the confluence of the North Fork Skagit River and Puget Sound. The Skagit River watershed is a core area and supports many local populations of bull trout. Based on studies from other nearby river systems and the Skagit River, bull trout in the lower Skagit River (below the dams) are fluvial or anadromous. Juveniles migrate downstream from their natal areas at approximately age 2 and may be present in the lower river. Many bull trout make

extensive use of the lower estuary and near shore marine areas for extended rearing, foraging and overwintering.

The Lower Skagit core area supports a spawning population of migratory bull trout that numbers in the thousands, making it the largest population in Washington. The nearest potential bull trout spawning habitat is found mostly on federally protected lands in the upper watershed. Water temperatures in the Lower Skagit River near the project site are cool (at or below 15°C, based on water quality monitoring data at Mount Vernon) and suitable for bull trout year-round. Based on the cool water temperatures and good habitat quality, we anticipate adult, subadult, and larger juvenile bull trout to be present in the project area during project implementation. Because of the level of increased turbidity during and after construction, the Service anticipates a significant impairment of normal behavior (disturbance) to bull trout associated with exposure to elevated levels of turbidity.

The project reach is designated as critical habitat. The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The following PCEs are present in the action area and may be affected by the proposed action:

PCE 1 -Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia. The proposed action is designed to improve flows and floodplain connectivity in the lower North Fork Skagit River. Construction of distributary channels and setback of the levees will intercept groundwater sources and improve hyphoreic connections. Because the project is designed to improve flows and tidal inundation in the floodplain, the long-term effects of the action on this PCE are considered beneficial.

PCE 2 - Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers. The proposed action may result in temporary impacts to water quality and disturbance associated with elevated levels of turbidity and suspended sediments. Construction of the distributary channels, breaching of the levees, and removing shore armoring will produce pulses of increased turbidity especially during the first high tides. Increased turbidity will be short-term and will not preclude bull trout movement through the area during and after construction. Long-term effects of the proposed action are expected to be beneficial because the lowering and breaching of the existing levee and the construction of distributary channel habitat will provide foraging habitat. Therefore, construction-related effects to this PCE are considered insignificant and long-term effects are anticipated to be beneficial.

PCE 3 - An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish. The proposed action may affect the food base of bull trout through short-term degradation of water quality and removal of some shrubs and overhanging vegetation. Upon completion of the proposed action, we anticipate that the newly planted riparian vegetation will, in one to five years, grow to provide some shade, habitat for terrestrial macroinvertebrates, and other organic inputs. The river reach provides habitat for juvenile

salmonids and a diversity of aquatic macroinvertebrates. The construction of distributary channels and removing levees will improve both habitat complexity and result in a net increase of up to 256 acres of tidally-influenced floodplain habitat which will support both terrestrial and aquatic prey species for bull trout. Therefore, long-term effects to this PCE are considered beneficial.

PCE 4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure. The primary objective of the project is to restore delta and nearshore functions and increase habitat and channel complexity in the action area through the removal and setback of levees, reconnection of distributary channels, and planting of riparian vegetation. No measurable short-term construction-related adverse impacts to this PCE are anticipated. Therefore, effects to this PCE are considered entirely beneficial.

PCE 7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph. The proposed action will create new tidal channels that will naturally evolve over time in the newly accessible areas due to levee setbacks. Because the purpose project will improve the natural hydrology, ecological processes, and natural channel complexity of the river, long-term effects to this PCE are considered beneficial.

PCE 8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited. Construction activities will result in short-term and localized elevated turbidity; the removal of berms, replacement of bridges, and in-water work during construction will result in short-term degradation of water quality in the vicinity of the project sites during construction and after construction during high flow events as sediments are redistributed across the floodplain and mixed with the river flows. Short-term impacts to water quality likely will be measurable, especially during high tides or storm events the first winter after construction. Pulses of turbidity will continue until the restored distributary channels and disturbed sites reach equilibrium (approximately 1 to 2 years after construction). The project site is located in the lower river just near the confluence with the marine environment where background levels of turbidity are relatively high. Because most of the restoration site is not currently accessible to fish and pulses of turbidity will be relatively short, the periodic impacts to water quality are not expected to affect normal reproduction, growth or survival of bull trout or forage fish in the project area. Long-term effects to this PCE are not expected to be measurable and are considered insignificant.

Incidental Take Statement

Given the duration of in-water work (two in-water work seasons), the Service anticipates individual bull trout that are in the project area to be exposed to elevated levels of turbidity and disturbance associated with excavation to remove shore armoring and breach the levees and in-water construction activities. Although we anticipate most of the adult bull trout to be upstream of the project reach in their natal streams preparing to spawn at the time that work will be

conducted, some non-reproductive adults, subadults and larger juvenile bull trout may be present in the action area.

Adverse effects to larger juvenile and subadult bull trout are anticipated from activities that generate high levels of turbidity and disturbance associated with use of heavy equipment, breaching of the levee, and construction of distributary channels. In-water work is scheduled to occur between June 15 and August 31 over two consecutive years. Elevated levels of turbidity are expected to extend downstream and upstream of each in-water work site. All adult, subadult, and juvenile bull trout that are present in the project reach and area of elevated turbidity will experience significant impairment of feeding, sheltering, and normal behavior (Harassment). The extent of take is along the riverbanks in the action area extending for approximately 2.2 river miles on the left bank and 0.5 mile on the right bank. All individuals that are present in areas that elevated turbidity and suspended sediments will occur (e.g., at the four breaches in the levees and armored banks) will be stressed. The duration of take is anticipated to be between June 15 and August 31 over two in-water work seasons.

Restoration of habitat complexity for bull trout will enhance the quality of suitable habitat with associated positive effects on long-term survival and recovery of the species. The proposed action meets all of the applicable criteria in the Fish Passage and Habitat Enhancement Restoration Programmatic (Programmatic) for Activity Category 3: Levee Removal and Modification, Category 4: Side Channel/Off Channel Habitat Restoration and Reconnection, Category 9: Debris and Structure Removal, and Category 11: Ecosystem Function Improvements. The Fifth Field HUC Code for this project is 1711000702 (North Fork Skagit River).

As per the criteria set forth in the Programmatic, the Service is responding via this electronic format to give approval to cover the proposed action under the Programmatic. The Corps has met their obligation under Section 7 of the Endangered Species Act and no further consultation on this action is required unless the project changes. Standard reinitiation triggers for consultation apply if: 1) new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, 3) a new species is listed or critical habitat is designated that may be affected by this project, and/or 4) the amount of incidental take exempted for the projects is exceeded. Turbidity reports should be sent to:

Eric V. Rickerson, State Supervisor
(Attn. Martha Jensen or Shirley Burgdorf)
Washington Fish and Wildlife Office
510 Desmond Drive SE
Lacey, Washington 98503

The U.S. Fish and Wildlife Service tracking number for this project is 01EWFW00-2016-TA-0204. If you have any questions, please contact Shirley Burgdorf at (360) 534-9340 or Martha Jensen at (360) 753-9000, of this office.

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
United States Department of the Interior
Fish and Wildlife Service

National Marine Fisheries Service
510 Desmond Drive SE, Suite 103
Lacey, Washington 98503

U.S. Fish and Wildlife Service
510 Desmond Drive S.E., Suite 102
Lacey, Washington 98503

May 29, 2012

Evan Lewis
Seattle District - U.S. Army Corps of Engineers
Post Office Box 3755
Seattle, Washington 98124-3755

Dear Mr. Lewis:

This letter documents the coordination between the Seattle District U.S. Army Corps of Engineers (Corps) and the National Marine Fisheries Service and U.S. Fish and Wildlife Service (Services) regarding permitting for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) proposed restoration projects. The Services express joint support for Corps' use of the new Fish Passage and Restoration Programmatic (FPRP) to consult on PSNERP projects. It is our intent to further review these proposed actions to determine which would be covered under the FPRP. The Services share an interest with the Corps in using the FPRP to address Endangered Species Act consultation requirements with most, if not all, of the PSNERP projects.

The Services are scheduled to continue writing a 2013 Fish Passage and Restoration Programmatic Opinion in the fall/winter of 2012 with anticipated completion prior to the 2013 construction season. This 2013 FPRP will replace the 2008 FPRP and update it for the additional species listed since 2008 and with additional action categories, mainly in the marine and estuarine environment.

The Services have reviewed the descriptions of the 15 initial PSNERP projects for which the Corps will likely be seeking construction authorization. Based on this initial review, we have drafted a new project category, Ecosystems Function Improvements (see Attachment 1) which is intended to cover restoration projects proposed by PSNERP. In developing the 2013 FPRP, we will work to further update project categories to provide programmatic coverage for restoration actions proposed by PSNERP where appropriate. These updates will necessarily be balanced by

the legal requirements of the Services' to ensure protection of species and habitats covered by the Endangered Species Act.

The Services' acknowledge the potential for PSNERP projects proposed by the Corps to make substantial improvements in the health of Puget Sound nearshore ecosystems. These projects also advance our shared responsibilities to recover listed species dependent upon nearshore ecosystems. It is our intent to continue to support the Corps mission of ecosystem restoration to the extent our legal authorities and resource capacity allows. Please contact Stephanie Ehinger (NMFS) and/or Martha Jensen (UWFW) if you require additional assistance in this matter.

Sincerely,

William W. Stelle, Jr.
Regional Administrator
NOAA Fisheries

Ken S. Berg, Manager
Washington Fish and Wildlife Office
U.S. Fish and Wildlife Service

ATTACHMENT 1: PROPOSED ADDITIONAL FPRP CATEGORY RELATED TO PSNERP

Ecosystem Function Improvements (draft language, may change in the final)

Description. The objective of ecosystem function improvements is to remove and/or replace shoreline infrastructure (e.g., roads, trails, railroad crossings, shoreline armoring, dikes, fill, docs and marinas, and nearshore dams) with significantly less impacting infrastructure to allow for improved self-sustaining ecosystem function including passage of aquatic organisms, sediment transport and delivery, channel migration, tidal flow, and large wood movement. These projects are generally larger in scope than culvert replacements which were a principal focus of the original 2008 FPRP programmatic and include replacement of causeways[1] that currently constrict estuaries or floodplains with elevated, floodplain-spanning structures. Projects must comply with the General Conservation Measures (GCMs) listed in the GCM section of this Programmatic Biological Assessment (PBA) as well as the Specific Conservation Measures listed below.

[1]A causeway is a road or railway elevated, usually across a broad body of water like an estuary or wetland.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No:
WCR-2015-3719

February 11, 2016

Michelle Walker
Chief, Regulatory Branch
Seattle District, Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Three Civil Works Wetland Restoration actions under the Puget Sound Nearshore Restoration Projects (PSNERP) in the Duckabush, Nooksack/Lummi, and North Fork Skagit River Estuaries (Jefferson, Skagit, and Whatcom Counties, Washington)

Dear Ms. Walker:

Thank you for your November 13, 2015 letter requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for Three PSNERP Restoration Actions under the Fish Passage Restoration Programmatic Consultation (NMFS No. NWR-2008-3598, et al). That programmatic consultation expired in 2014. Therefore, NMFS considered each of the three PSNERP actions against the backdrop of the expired programmatic and its requirements and prepared the attached biological opinion batching those considerations for efficiency and to streamline reviews.

As required by section 7 of the Endangered Species Act, the National Marine Fisheries Service provided an incidental take statement with the biological opinion. The incidental take statement describes reasonable and prudent measures the National Marine Fisheries Service considers necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions. Incidental take from actions that meet the term and condition will be exempt from the Endangered Species Act take prohibition.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes one conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. This conservation recommendation is a subset of the ESA take statement's terms and conditions. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the Federal action agency must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please contact David Hirsh, (206) 526-4506 or david.hirsh@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat

Three Civil Works Wetland Restoration actions under the Puget Sound Nearshore Restoration Projects (PSNERP) in the Duckabush, Nooksack/Lummi, and North Fork Skagit River Estuaries (Jefferson, Skagit, and Whatcom Counties, Washington)

NMFS Consultation Number: WCR-2015-03719

Action Agency: United States Army Corps of Engineers, Seattle District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook salmon(*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Puget Sound steelhead (*O. mykiss*)	Threatened	Yes	No	No
Hood Canal Summer chum salmon *(O. keta)*	Threatened	Yes	No	No
Southern Resident Killer Whale *(Orcinus orca)*	Endangered	No (see section 2.11)	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

William W. Stelle, Jr.
Regional Administrator

Date: February 11, 2016

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402. Please contact David Hirsh of the Oregon Washington Coastal Area Office at 206-552-3965, or by e-mail at david.hirsh@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

1.2 Consultation History

On November 13, 2015, the COE sent NMFS three individual actions to be processed under the NMFS's 2008 Programmatic Consultation with the COE on Fish Passage and Restoration actions in Puget Sound (NMFS Nos. NWR-2008-3598 and WCR-2014-10665). NMFS No. NWR-2008-3598 expired in 2013 and WCR-2014-10665 expired in 2014 without an express request to consult anew on the program in its current form.

Since the COE submitted information covering these three actions in the format dictated in NMFS No. NWR-2008-3598, NMSF coordinated with the COE to determine the most efficient method for conducting ESA section 7 interagency consultation on the three actions. As a result of those discussions, NMFS and the COE determined to batch all three actions into a single biological opinion reflecting individual consultations on the actions while ensuring to incorporate all relevant information from the expired restoration programmatic opinion. Relying on conceptual design information, measures present in the PSNERP program, and the prescriptive and some analytical elements in NMFS No. NWR-2008-3598, NMFS initiated consultation on January 22, 2016.

The administrative record for this consultation includes the specific project information forms and Memo for the Services submitted by the COE under the expired Fish Passage and Restoration Programmatic. In addition, NMFS gathered information on the underlying PSNERP program all of which is on file with NMFS.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). At the time of consultation, NMFS did not identify any actions interrelated to or interdependent on the proposed action.

The COE submitted three individual nearshore restoration projects developed under the Puget Sound Nearshore Ecosystem Restoration Program (PSNERP) for consideration under an expired programmatic consultation (NMFS No. NWR-2008-3598) covering COE fish passage restoration actions in Puget Sound. These projects are:

1. Duckabush River and wetlands at the Highway 101 crossing, near the town of Duckabush, Jefferson County, Washington (47.649175 N latitude, -122.934644 W longitude)
2. Nooksack River near Ferndale, Whatcom County, Washington (48.826772 N latitude, -122.593378 W longitude)
3. North Fork (NF) Skagit River near Mt. Vernon, Skagit County, Washington (48.35825 N latitude, -122.4355 W longitude)

Although that programmatic consultation is expired, the prescriptive elements of NMFS No. NWR-2008-3598 remain acceptably protective of listed fish and their habitat. Therefore, those measures are incorporated into the proposed actions batched for this consultation and excerpted below. The COE commits to integrate these measures, as appropriate, into each of the three actions. If the COE determines that it cannot integrate an otherwise appropriate prescription from NMFS No. NWR-2008-3598, the COE will contact NMFS staff to determine whether or not to reinitiate consultation on that action.

The PSNERP's restoration strategies are aimed at restoring damaged or degraded ecosystem processes. Process-based restoration involves making intentional changes to an ecosystem to allow erosion, accretion, tidal exchange, accumulation of wood debris, and other natural process to occur. Process-based restoration is often distinguished from species-based restoration which aims to improve the services an ecosystem provides to a single species or group of species as opposed to improving the entire ecosystem. In PSNERP's framework, each candidate restoration action involves removing one or more ecosystem *stressors* using specific *management measures*. Stressors are physical alterations that interrupt, preclude, or displace nearshore processes such as stream crossings and shoreline modification that prevent the function of processes that create and maintain habitat and access to it (PSNERP 2012).

The PSNERP restoration actions considered in this consultation will consist of activities from at least or more of the following categories of restoration activities and the associated conservation measures. These measures are excerpted directly from NMFS No. NWR-2008-3598.

1.3.1 Categories of Restoration Activities and Applicable Minimization Measures

1. Fish Passage

Description: The objective of passage barrier removal is to allow all life stages of salmonids access to historical habitats from which they have been excluded by non-functioning drainage structures (road, trail, and railroad crossings) and water impoundments (tide gates, temporary dams).

a. Culvert Replacement and Relocation

Description: Culverts at road crossings will be replaced with bridges, appropriately sized culverts, bottomless culverts, or arch pipes. Culverts may be replaced with slightly longer culverts to accommodate safety improvements. Culverts may be relocated to restore natural hydrology and stream alignment.

Conservation Measures:

1. When there is a series of barriers on one system that are scheduled to be resolved in a short period of time, work will start at the most upstream barrier. This way, the work at the more upstream sites can be done without listed fish in the action area.
2. Road crossings will be designed to the culvert design benchmarks set in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual (http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish_Passage_Design.pdf) except for the deviations mentioned below. The Washington Department of Fish and Wildlife (WDFW) technical guidance manual Design of Road Culverts for Fish Passage (Bates et al. (2003)) may be used to achieve these benchmarks.
3. Where site specific designs lead to a conflict in design standards, a solution will be proposed by the designer. This solution will be used as a basis of talks between the Services, WDFW, and the project applicant. The final design needs to be approved by the Services.
4. Projects in stream channel with gradients above six percent will preferably utilize a bridge. If that is not feasible, crossings will be designed using the stream simulation option. For culverts in fish bearing streams with gradients higher than six percent the Services can request monitoring data of: 1) placed substrate integrity and bedload deposition; 2) inlet and outlet conditions; and 3) channel form (structural elements of high gradient channel: boulders, pools, low flow channel) after the first 10 year flow (or higher) events. The Services will require a maintenance plan to assure the crossing remains within design conditions.
5. Culvert replacements on fish-bearing streams will be designed to provide upstream and downstream passage for juvenile and adult salmonids using the criteria below (6-17).
6. Project designs for stream simulation will meet the WDFW (Bates et al. (2003)) design standards for width (for confined to moderately confined channels: width of the culvert bed to equal 1.2 * bankfull width + 2 feet; unconfined channels will require a larger span).
7. The hydraulic design method is a design process that matches the hydraulic performance of a culvert with the swimming abilities of a target species and age class of fish. There are significant errors associated with estimation of hydrology and fish swimming speeds that are resolved by making conservative assumptions in the design process. Determination of the high and low fish passage design flows, water velocity, and water depth is required for this option. Designs will meet the WDFW (Bates et al. (2003)) flow range criteria and will be designed to accomplish fish passage between the 7

consecutive days, 2 year low flow and the 10 percent exceedance flow (the flow that is exceeded only 10 percent of the time; high design flow). Additionally, the high design flow will be calculated based on the life histories of the target fish species[1], and time periods they are most likely to be moving upstream. This design method may be applied to the design of new and replacement culverts and may be used to evaluate the effectiveness of retrofits of existing culverts.

Hydraulic design is limited to situations where:

a. Channel gradient is low to moderate, generally less than 3 percent. If it is not possible to embed/countersink the culvert, the maximum channel gradient should not exceed 0.5 percent.
b. The bottom of the culvert should be buried into the streambed a minimum of 20 percent of the height of the culvert below the elevation of the tailwater control point downstream of the culvert, and the minimum embedment must be at least 1 foot.

8. Active channel (no-slope/embedded pipe): This method provides a simplified design intended to provide a culvert of sufficient size and embedment to allow the natural movement of bedload and the formation of a stable bed inside the culvert. It is intended for use only in very small streams. Determination of the high and low fish passage design flows, water velocity, and water depth is not required for this method, since the stream hydraulic characteristics within the culvert are intended to mimic the stream conditions upstream and downstream of the crossing. Structures for this design method are typically round, oval, or squashed pipes made of metal or reinforced concrete. Culverts are installed level at 0 percent slope.

Design is limited to situations where:

a. The natural slope is less than 3 percent and the culvert length is less than 80 feet.
b. The bottom of the culvert should be buried into the streambed not less than 20 percent of the culvert height at the outlet and not more than 40 percent of the culvert height at the inlet. For example, in a ten foot diameter circular culvert the downstream end invert has to have at least 2 feet of substrate.
c. At a minimum the culvert width has to be equal to the average channel bed width at the elevation the culvert meets the streambed; generally this elevation is at 20 percent to 30 percent of its diameter (see above, 8b). Thus, combining the requirements of countersinking the outlet and the culvert width for a circular culvert, the diameter must be at least 1.25 times the channel bed width.

[1] Target Fish Species are generally all adults and juveniles of the species for which the subject area has been designated as critical habitat. However, deviations can be suggested by the applicant and implemented with agreement by both NMFS and WDFW. There may be cases where NMFS may require additional species passage.

The culvert bed slope (S in units of length/length or rise/run) times culvert length (L) is less than or equal to 20 percent of the culvert diameter (D). S*L<0.2*D (Chapter 4 (Bates et al. 2003)). Thus, culverts utilizing the no-slope option are generally less than 75 feet long.

Length (ft)	Slope	S*L	Channel Bed Width CBW (ft)	Diameter Culvert D=1.2* CBW	0.2*D
50	0.02	1	6	7.2	1.44
50	0.03	1.5	8	9.6	1.92
75	0.02	1.5	10	12	2.4
75	0.03	2.25	12	14.4	2.88

9. Culverts longer than: 150 feet for stream simulation, 75 feet for no-slope and 500 for any other option are excluded under this programmatic.
10. Culvert widths greater than 20 feet are excluded under this programmatic, because for widths greater than 20 feet a bridge generally provides better passage.
11. For any design, the proponent will demonstrate that the design condition can be maintained over the expected life of the culvert. This includes maintaining placed bed material in the culvert.
12. All sites will have a maintenance plan that assures that the culvert will be in design condition prior to each fish passage season. The best designed culvert will not provide passage if it is blocked by debris, or if energy dissipation features are compromised.
13. Bridge footings will be located outside of the ordinary high water line (OHWL).
14. Hard bank stabilization at crossing structures will be limited to the width of the existing road fill prism.
15. Grade control structures to prevent headcutting above or below the culvert or bridge may be built using rock or wood. Grade control structures typically consist of boulder and/or wood structures (see below: Grade Control Engineered Log Jams (ELJs), Boulder Weirs and Roughened Channels) that are keyed into the banks, span the channel, and are buried in the substrate. Grade control structures will provide fish passage for juvenile and adult salmonids, and will be designed to most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.
16. Designs will demonstrate that ecological functions including bedload movement, large wood and other debris movement, and flood flows can occur as appropriate to the site.

b. Retrofitting Culverts

Description: Where culvert replacement is not currently feasible, culverts may be retrofitted in the short term to improve passage by installing structures including baffles and step-and-pool weirs at outlets.

Conservation Measures:

1. Projects will be retrofitted to meet the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual or WDFW's fish passage criteria for salmon and trout (Bates et al. 2003).
2. Projects will demonstrate a commitment to a long-term solution. A retrofitted culvert will be replaced with a bridge or culvert that is at the time of retrofitting scheduled and funded and that meets the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.
3. All retrofitted culverts will have a maintenance plan which assures that the fishway will be maintained to provide original design conditions prior to each fish passage season and inspected at least after every 10 year flow event.

c. Culvert Removal

Description: Removal of unnecessary culverts to improve salmonid access and habitat functions. When circumstances permit, culvert removal is the preferred alternative.

Conservation Measures: When there is a series of barriers that are proposed to be removed in a short period of time on one system, work will start at the most upstream barrier to minimize impacts to listed fish.

d. Tidegate Removal

Description: Removal of unnecessary or non-functioning tide gates to restore salmonid access to historic estuarine habitats.

e. Removal or Modification of Sediment Bars or Terraces that Block or Delay Salmonid Migrations

Description: Land use practices such as timber harvest, large scale agriculture and urban development have resulted in increased, generally fine, sediment delivery to streams. This sediment can accumulate in low velocity areas and contribute to widening of stream mouths, forming bars or terraces. The bar or terrace can spread the streamflow into finely braided or sheet flow patterns, forming low flow fish passage barriers. These temporary blockage points often provide opportunities for illegal snagging of holding adult salmon. The COE proposes to restore fish passage by removing sediment to restore flow conditions that allow for passage.

Conservation Measures:

1. The maximum amount of material removed from a passage impediment is 100 cubic yards.
2. If the removed material contains more than 60 percent silt or clay it will be disposed of upland. Material with more than 40 percent gravel will be deposited within the active floodplain, but not in wetlands. Material with more than 50 percent gravel and less than 30 percent fines (silt or clay) may be deposited below the OHWL. If material is deposited below the OHWL the applicant will explain the expected benefits, e.g. use as bankfull bench for riparian plantings in area where flood storage is not an issue.

3. If the removed material is suitable for spawning it may be used within the watershed for spawning gravel supplementation including below dams and in sediment-starved reaches.
4. Sandbags may be placed to temporarily improve fish passage. Sandbags will be removed prior to anticipated high flows that could wash away sandbag or cause flow to go around them.
5. If removal of sediment at the same location is proposed for a second time within ten years, a long term plan for a solution other than sediment removal will be presented. For example, placement of large wood can result in scour that may alleviate the local passage impediment.

f. Temporary Placement of Sandbags, Hay Bales, and Ecology Blocks to Improve Salmonid Passage

Description: Land use practices such as large scale agriculture, including irrigation, and urban and residential development have changed the hydrology of affected watersheds. Reduced forest cover and increased impervious surface have resulted on the one hand in increased runoff and peak flows and on the other hand in less aquifer recharge and resulting increased frequency, duration and magnitude of summer droughts. During recent droughts, temporary placement of sandbags, hay bales, and ecology blocks have been successful in providing short-term fish passage, especially in Eastern Washington. The COE proposes to utilize these techniques to restore fish passage during seasonal low flow periods.

Conservation Measure: All material placed in the stream to aid fish passage will be removed when stream flows increase, prior to the onset of the fall rains.

g. Construction of Structures to Provide Passage over Small Dams

Description: Diversion dams, generally in Eastern Washington, often create a permanent or temporary fish passage blockage. The COE proposes to build structures at existing dams to restore fish passage. Structures will be constructed from rock or wood or a combination of rock and wood. Examples of designs of structures include Rock Chevrons and V-weirs.

Conservation Measures:

1. Construction of passage structures over irrigation dams is limited to dams of less than seven feet in height.
2. NMFS engineers are presented with plans for and approve of passage projects at structures that are between 3 and 7 feet high.
3. Construction of passage structures is limited to facilitate passage at existing diversion dams, not in combination with new dams.
4. The design of passage structures will follow the appropriate design standards in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.

Specifically Excluded Activities:

- Tidegate and floodgate replacements are not proposed for this consultation and need be addressed project by project.
- Installation of fish ladders to create passage around blockages higher than

seven feet is not proposed under this programmatic biological assessment (PBA).

- Culvert replacements for road capacity improvements are not proposed under this PBA.

2. Installation of Instream Structures

Anthropogenic activities that have altered riparian habitats, such as splash damming and the removal of large wood and logjams, have reduced instream habitat complexity in many rivers. They have eliminated or reduced features like pools, hiding cover, and bed complexity. Salmonids need habitat complexity for rearing, feeding, and migrating. To improve habitat complexity where an identified need exists, the COE proposes to permit the following practices:

a. Placement of Woody Debris

Description: Large Woody Debris (LWD) can be placed in the channel, estuary, or marine environment either unanchored or anchored in place using rock, rebar, or wooden piles. The amount of rock used is limited to that needed to anchor the LWD. The use of metal cables will be limited to situations where no other technique will work.

Conservation Measure: Large trees may be dislodged or felled for constructing in-stream habitat in areas where the following criteria are met: (1) Lack of instream LWD has been identified by a watershed analysis, reach assessment, or similar document as a limiting factor for the subject reach; and (2) Presence of an adequately stocked and healthy mature riparian forest; (3) Felling or tipping (or both) of trees into the water will not significantly impact stream shading; (4) Sufficient natural recruitment of native woody vegetation is expected and the threat of invasive vegetation filling created gaps is minimal or replanting with native woody species is planned; (5) The LWD design aims at providing several years of in-stream habitat benefits; (6) The trees are not suitable habitat for listed terrestrial species. Whenever possible, rootwads will be used for in-stream habitat, too. Attempts will be made to procure and stockpile LWD to be used before felling live trees. Finally, felling trees may be most appropriate where stream access is limited for creating LWD jams.

b. Placement of Live Stakes

Description: This technique consists of planting of live cottonwood stakes perpendicular in the ground. The arrays are planted either perpendicular, at slight angles to, or parallel to the flow/course of the river; in the floodplain or into the active channel, depending on the objective of the project. Objectives of flood fencing include:

i. Establish riparian vegetation and mimic (hydraulically) a mature riparian forest. Spaces between rows may be planted with additional riparian vegetation.
ii. Create habitat complexity. The live stakes slow water velocities and collect/catch debris and sediment during bankfull and flood events.
iii. Slow water velocities to reduce scour in the vicinity of riparian plantings, increasing successful establishment of new riparian plantings,
iv. Decrease width to depth ratios in widened channel reaches,
v. Create backwater effects to allow natural reconnection of side channels.

The installation of flood fences is accomplished by boring with augers and placing boles vertically into arrays, or by trenching in adjacent, and staggered, rows to create arrays.

Conservation Measures: All materials removed are replaced once boles are in place, and in fact, are used to reduce scour around boles during the first bankfull events. Boles are generally sealed on the top to prevent excessive desiccation. In sensitive areas, such as side channels and bar locations, this step is omitted.

c. Placement of Engineered Log Jams

Description: For detailed descriptions of each technique refer to the Stream Habitat Restoration Guidelines (Saldi-Caromile et al. 2004), the Integrated Streambank Protection Guidelines (Cramer et al. 2003), and the Conceptual Design Guidelines: Application of Engineered Logjams (Herrera 2006). Engineered log jams are designed collections of LWD. Different types of ELJs include bank protection ELJs (see below, General CM), bar apex ELJs, and grade control ELJs (see below). Engineered log jams are patterned after stable natural log jams and can be either unanchored or anchored in place using rebar, rock, or piles (steel may be used if other long term anchoring is not possible at site. Explain in SPIF). Engineered log jams create a hydraulic shadow, a low-velocity zone downstream that allows sediment to settle out. Scour holes develop adjacent to the log jam. While providing valuable fish and wildlife habitat they also redirect flow and can provide stability to a streambank or downstream gravelbar.

Excluded Activities: Logjams with a primary purpose other than habitat restoration or enhancement.

d. Grade Control Engineered Log Jams

Description: Grade control ELJs are designed to arrest channel downcutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks. Grade control ELJs also serve to protect infrastructure that is exposed by channel incision and to stabilize over-steepened banks. Unlike hard weirs or grade control structures, a grade control ELJ is a complex broad-crested structure that dissipates energy more gradually. Examples of grade control ELJs include Bronson Creek, Portland, Oregon (Herrera 2006).

e. Trapping Mobile Wood

Description: Construction of wood structures to trap mobile wood. Wood may be anchored with rebar, anchor rocks, and untreated wood pilings. Less than 10 inch diameter steel pilings may be used if necessary for stability reasons. Examples of streamside LWD catchers are outlined in Slaney P.A. and D. Zaldokas (1997), http://nfcp.org/Archived_Reports/RM97-2.pdf and http://nfcp.org/Archived_Reports/RM96-3.pdf. The Lower Columbia Fisheries Enhancement Group which operates in southwest Washington has installed several of these structures and is willing to offer limited design help.

Conservation Measures: In the marine environment, steel piles will not be driven with an impact hammer.

f. Placement of Boulders

Description: Placement of individual large boulders and boulder clusters to increase structural diversity. Structural and hydraulic diversity is important to provide holding and rearing habitat for salmonids. As with all proposed methods, this treatment will be used in streams that have been identified as lacking structural diversity and that naturally and/or historically had boulders. (Boulders may have been removed historically to facilitate wood transport.) For a more detailed description of potential applications see "Boulder Clusters" in WDFW (2004). Preferably, boulders will be sized and located to avoid the need for anchoring. However, if necessary for design objective, boulders placed on bedrock may be pinned with for example epoxy resin (Hilty system) to ensure long-term stability (Slaney and Zaldokas 1997).

Excluded Activities: Boulders may not be cabled in systems other than bedrock.

g. Boulder Weirs and Roughened Channels

Description:

Full channel-spanning boulder weirs will be installed to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, etc.). Boulder weirs and roughened channels may also be installed for grade control at culverts (see No. 1 above) and constructed side channels. For boulder weirs in wood dominated systems, grade control ELJs (see above) will be used.

Conservation Measures:

1. Boulder weirs will be installed only in:
    a. Highly uniform, incised, bedrock channels.
    b. Stream channels that have been artificially confined between levees or other floodplain revetments that are not feasible to remove or set-back.
    c. Locations for which salmonid recovery plans identifies channel spanning boulder weirs as a priority restoration technique (e.g. lower Entiat River).
    d. To provide grade control at culverts or constructed side channels.
2. Boulder weirs will be low in relation to channel dimensions so that they are completely overtopped during channel-forming, bankfull flow events (approximately a 1.5-year flow event).
   Boulder weirs will be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.
3. Boulder weirs will be constructed to allow upstream and downstream passage of all native listed fish species and life stages that occur in the stream at all flows.
4. The project shall be designed and inspected by a multidisciplinary team (including a salmon or trout biologist) that has experience with these types of structures.
5. Full spanning boulder weir placement will be coupled with measures to

improve habitat complexity and protection of riparian areas to provide long-term inputs of LWD to the maximum extent possible.

6. Roughened channels will be designed to standards contained in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.

h. Gravel Placement Associated with Structure Placement

For work in gravel-deficient areas, a maximum of 100 cubic yards of clean, washed, appropriately sized gravel (river-run gravel, not quarry spalls or crushed gravel) can be imported or relocated and placed upstream of each structure. When placing LWD on the outside of meander bends, bar material can be removed from the inside of the meander bend and relocated immediately up and/or downstream of the new structure. If the work area on the gravel bar is dry, work may be performed without use of a coffer dam. This gravel relocation would be expected to speed up the realignment of the thalweg and protect the new structure.

Excluded Activities:

- Construction of instream structures with a primary purpose other than habitat enhancement.
- Construction of boulder weirs or other channel spanning structures in gravel or finer substrate dominated streams.
- Gravel shall not be placed in areas are currently suitable for salmonid spawning

3. Levee Removal and Modification

Description: Levee modification or removal serves many purposes including habitat restoration, erosion reduction, water quality improvements, reduced high flow velocities, groundwater recharge and reduction of floods in other sections of the river. Techniques that are covered by this programmatic need to have the sole purpose of restoring flood plain functions or to enhancing fish habitat. Covered actions in freshwater, estuarine, and marine areas include:

- Full and partial removal of levees, dikes, berms, and jetties.
- Breaching of levees, dikes and berms.
- Lowering of levees, dikes and berms.
- Setback of levees, dikes and berms.

Conservation Measures:

1. Non-native dike and levee material will be hauled to an upland site to the greatest degree practicable.
2. Native material may be spread across the floodplain in a manner that does not restrict floodplain capacity and minimizes juvenile stranding. If the material is used to create/alter microtopograhphy it has to be done in a manner to minimize juvenile stranding. This can be achieved by sloping side channels to the main channel or water body and by designing access channels for depressional areas. These restrictions on microtopography in the floodplain only apply, if the project contains elements of altering/designing floodplain microtopography like side channels and depressions.

3. Ditches previously constructed to drain wetlands will be filled preferably with native material, otherwise with clean imported material of similar substrate to the adjacent/native banks.
4. In setback dikes/levees the amount of rock will be kept to a minimum. However, up to the same amount of hard material as in the to be replaced dike/levee may be used.

4. Side Channel/Off-Channel Habitat Restoration and Reconnection

Description: Side channel habitats are generally small watered remnants of river meanders. They provide important spawning and rearing habitat for juveniles and refuge habitat during high flows. They are most common in floodplains that have been strongly glacially influenced leaving alluvial material in a flat valley floor. Off-channel habitat includes abandoned river channels, spring-flow channels, oxbows and flood swales. Off-channel habitat has been reduced by human activities in the floodplain including diking, removal of LWD, straightening of the channel, and bank armoring. Thus, there is a need in many Washington watersheds for off-channel restoration.

Restoration techniques covered by the Biological Assessment (BA) focus on the restoration or creation of self-sustaining off-channel habitat. Self-sustaining is not synonymous with maintaining a static condition. Self-sustaining means the restored or created habitat would not require major or periodic maintenance, but function naturally within the processes of the floodplain. However, up to two project adjustments, including adjusting the elevation of the created side channel habitat are included under this proposal. The long-term development of a restored side channel will depend on natural processes like floods and mainstem migration. Over time, the side channel may naturally get drier or be taken over by the main river flow.

The following off-channel restoration activities are covered under the BA:

- Creation of new side channel habitat. This approach would create self-sustaining side channels which are maintained through natural processes. Designs must demonstrate sufficient hydrology.
- Excavating pools and ponds in the historic floodplain/channel migration zone to create connected wetlands.
- Reconnecting existing side channels with a focus on restoring fish access and habitat forming processes (hydrology, riparian vegetation).
- ELJs, barbs and groins may be used to direct some flow through a side channel, see below General Conservation Measures 1.
- Restoration of existing side channels including one-time dredging and an up to two times project adjustment including adjusting the elevation of the created side channel habitat.

Conservation Measures:

1. All side channel and pool habitat work will occur in isolation from waters occupied by listed fish species until project completion, at which time a final opening may be made by excavation to waters occupied by listed fish or water will be allowed to return into the area.
2. Side channel habitat will be constructed to prevent fish stranding by providing a continual positive grade to the intersecting waters of the US or a year around water connection.

9. Debris and Structure Removal

Description: The COE proposes to remove manmade debris and structures from freshwater and marine habitats. Examples of structures or debris that could be removed include derelict vessels, bank protection and shore armoring, creosote treated timbers, piers, ramps, and boat launches.

1. Removal methods for derelict vessels may include use of floatation bags or slings (hydraulic jetting can be used to place slings); cutting up and disposing of the hull at an approved disposal site; use of a crane and heavy equipment to transport all or part of the vessel away; or sinking (all toxic material and liquids must be removed first).
2. Structures that extend into the water (e.g. docks, floats, pilings, or piers) are generally removed using a barge with a clamshell bucket or crane assembly. Creosote-treated piles should be pulled out or cut off at the mud line and covered with clean sediments.
3. Shoreline structures and debris such as boat ramps, bank protection, shore armoring, creosote-treated logs or timbers, derelict buildings or other material are generally removed using land-based equipment and taken to an upland disposal site.

Conservation Measures:

1. If the removal involves the use of hydraulic jetting for sling placement and the vessel or debris is embedded more than three feet in bottom sediments, work will be accomplished during the appropriate marine or freshwater work windows.
2. All toxic materials such as fuel and oil will be removed from the vessel before it is towed or removed.
3. Creosote-treated timbers and materials containing asbestos will be disposed of at an approved facility.
4. In the marine environment, beach nourishment with appropriately sized substrate may accompany the removal of shoreline armoring.
5. After removing bank protection, the bank will be revegetated with native species.
6. After removing hard bank protection like rip-rap or sheet pile the bank may be stabilized with soft stabilization methods as in "General CM Frequently Associated with Some Restoration Actions 7" (p. 25).

Excluded Activities:

- Removal of vessels in contaminated sediments or in superfund sites.
- Removal of vessels in eelgrass, kelp beds or other macroalgae in a documented herring or foragefish spawning area.

1.3.3 General Prescriptions that Apply to all Proposed Restoration Actions

1. Pre-Construction/Surveying

1. All organic material that has to be cleared for access will remain on site.
2. The removal of riparian vegetation for access will be minimized and estimated in the Specific Project Information Form (SPIF) at the time the COE seeks to conduct the action.
3. The number of temporary access roads will be minimized and roads will be designed to avoid adverse effects like creating excessive erosion.
4. Temporary access-ways across slopes greater than 30 percent will be avoided. If temporary access needs to cross slopes greater than 30 percent it will be indicated in the SPIF.
5. No permanent access-ways will be built. All temporary access-ways will be removed (including gravel surfaces) and planted after project completion.
6. New temporary stream crossings will avoid potential spawning habitat (i.e. pool tailouts) and pools to the maximum extent possible. They will minimize sedimentation impacts by using best management practices like mats and boards to cross a stream. Best management practices will be listed by each applicant in a SPIF. After project completion temporary stream crossing will be abandoned and the stream channel restored where necessary.
7. Boundaries of clearing limits associated with site access and construction will be marked to avoid or minimize disturbance of riparian vegetation, wetlands, and other sensitive sites.
8. A Pollution and Erosion Control Plan, commensurate with the size of the project, must be prepared and carried out to prevent pollution caused by surveying or construction operations.
9. A supply of emergency erosion control materials will be on hand and temporary erosion controls will be installed and maintained in place until site restoration is complete.

2. General

1. Work windows will be applied to avoid and minimize impacts to listed salmonids or forage fish.
2. Electrofishing is not proposed in the vicinity of redds from which fry may not have emerged, or in areas where adult salmonids may be holding prior to spawning.
3. Sandbags may be placed to temporarily keep fish out of work areas. Sandbags will be removed after completion of project.
4. Temporary roads in wet or flooded areas will be abandoned and restored by the end of the in-water work period.
5. Existing roadways or travel paths will be used whenever possible.
6. Any large wood, native vegetation, weed-free topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration.
7. When construction is finished, the construction area will be cleaned up and rehabilitated (replanted and reseeded) as necessary to renew ecosystem processes that form and maintain productive fish habitats.

8. Work below the OHWL or mean lower low tide line will be completed during preferred in-water work windows, when listed salmonids or forage fish are least likely to be present in the action area. Exceptions will be requested in the SPIF.
9. If listed fish are likely to be present, the project sponsor will assess what is less impacting to fish, isolation of the in-water work area or work in the wet, see below "6. Isolation of Work Site".
10. Prepare a Work Area Isolation Plan for all work below the bankfull elevation requiring flow diversion or isolation. Include the sequencing and schedule of dewatering and rewatering activities, plan view of all isolation elements, as well as a list of equipment and materials to adequately provide appropriate redundancy of all key plan functions (e.g., an operational, properly sized backup pump and/or generator). This standard material does not need to be submitted with a SPIF. However, it needs to be available to the Services at their request.
11. Any water intakes used for the project, including pumps used to dewater the work isolation area, will have a fish screen installed, operated and maintained according to NMFS' fish screen criteria (NMFS 1997; NMFS 2008).
12. The site will be stabilized during any significant break in work.
13. Project operations will cease under high flow conditions that may inundate the project area, except as necessary to avoid or minimize resource damage.
14. All discharge water created by construction (e.g., concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) will be treated to avoid negative water quality and quantity impacts. Removal of fines may be accomplished with bioswales; concrete washout with altered ph, may be infiltrated.

3. Equipment

1. Heavy equipment will be limited to that with the least adverse effects on the environment (e.g., minimally-sized, low ground pressure equipment).
2. When not in use, vehicles and equipment that contain oil, fuel, and/or chemicals will be stored in a staging area located at least 150 feet from the COE' jurisdictional boundary of wetlands and waterbodies. If possible staging is located at least 300 feet away from the COE's jurisdictional boundary of wetlands and waterbodies, and on impervious surfaces to prevent spills from reaching ground water. Where moving equipment daily at least 150 feet of waterbodies would create unacceptable levels of disturbance (multiple stream crossings, multiple passes over sensitive vegetation) a closer staging location with an adequate spill prevention plan may be proposed.
3. When conducting in-water or bank work, hydraulic lines will be filled with vegetable oil for the duration of the project to minimize impacts of potential spills and leaks.
4. Spill prevention & clean-up kits will be on site when heavy equipment is operating within 25 feet of the water.
5. To the extent feasible, work requiring use of heavy equipment will be completed by working from the top of the bank.
6. Equipment shall be checked daily for leaks and any necessary repairs shall be completed prior to commencing work activities around the water.
7. Equipment will cross the stream in the wet only under the following conditions:
   a. equipment is free of external petroleum-based products, soil and debris has been

removed from the drive mechanisms and undercarriage; and
b. substrate is bedrock or coarse; and
c. in soft bottom streams mats or logs are used to drive across to minimize compaction; and
d. stream crossings will be performed at right angle if possible; and
e. no stream crossings will be performed at spawning sites when spawners are present or eggs or alevins could be in the gravel; and
f. the number of crossings will be minimized.

4. Planting and Erosion Control

1. Within seven calendar days of project completion, any disturbed bank and riparian areas shall be protected using native vegetation or other erosion control measures as appropriate. For erosion control, sterile grasses may be used in lieu of native seed mixes.
2. If native riparian vegetation has to be disturbed it will be replanted with native herbaceous and/or woody vegetation after project completion. Planting will be completed between October 1 and April 15 of the year following construction. Plantings will be maintained as necessary for three years to ensure 50 percent herbaceous and/or 70 percent woody cover in year three, whatever is applicable. For all areas greater than 0.5 acres, a final monitoring report will be submitted to the COE in year three. Failure to achieve the 50 percent herbaceous and 70 percent woody cover in year three will require the applicant to submit a plan with follow up measures to achieve standards or reasons to modify standards.
3. Fencing will be installed as necessary to prevent access to revegetated sites by livestock, beavers or unauthorized persons. Beaver fencing will be installed around individual plants where necessary.

5. Water Quality

1. Landward erosion control methods shall be used to prevent silt-laden water from entering waters of the United States. These may include, but are not limited to, straw bales, filter fabric, temporary sediment ponds, check dams of pea gravel-filled burlap bags or other material, and/or immediate mulching of exposed areas.
2. Wastewater from project activities and water removed from within the work area shall be routed to an area landward of the OHWL in an upland disposal site to allow removal of fine sediment and other contaminants prior to being discharged to the waters of the United States.
3. All waste material such as construction debris, silt, excess dirt, or overburden resulting from this project will generally be deposited above the limits of flood water in an upland disposal site. However, material from pushup dikes may be used to restore microtopography, e.g. filling drainage channels.
4. If high flow or high tide conditions that may cause siltation are encountered during this project, work shall stop until the flow subsides.

Measures shall be taken to ensure that no petroleum products, hydraulic fluid, fresh cement, sediments, sediment-laden water, chemicals, or any other toxic or deleterious

materials are allowed to enter or leach into waters of the US. A spill prevention plan will be prepared for every project that utilizes motorized equipment or vehicles. Plan will be available to Service by request. An erosion control plan will be prepared for every project that results in ground disturbance. Plan will be available to Service by request.

6. Isolation of Work Site

To reduce impacts to listed fish and water quality, major habitat restoration projects would be performed in isolation from flowing waters whenever possible. Examples of activities that may be done in the water include placing wood and rock structures that require very little in-water excavation, small scale work in systems with sand or coarser grained substrate and work in rock bottom systems. The choice and rational on whether or not to isolate the worksite needs to be included in the SPIF. The focus needs to be on minimization of impacts on water quality, listed salmonids and forage fish. If worksite isolation and fish capture and removal is the least impacting method, the applicant will follow procedures outlined in Appendix D of NMFS No. NWR-2008-3598.

When working in the wet some turbidity monitoring may be required, subject to discussions between applicant and the Services. Turbidity monitoring generally is required when working in streams with more than 40 percent fines (silt/clay) in the substrate. Turbidity will be monitored only when turbidity generating work takes place, for example, pulling the culvert in the wet, reintroducing water. The applicant will measure the duration and extent of the turbidity plume (visible turbidity above background) generated. The data will be submitted to the Services.

Measurements of concentration preferably in mg/l are very helpful for the Services. Turbidity measurements are used by the Services to develop procedures to minimize turbidity and estimate take for future projects. If you can provide turbidity measurements in mg/l (NTUs are also less helpful for purposes of comparison with literature values) the Services will greatly appreciate your data.

1.3.4 General Prescriptions that Apply to some of the Proposed Restoration Actions

1. Installation of Bank Stabilization Features:

Description: In many riparian areas anthropogenic activities have led to streambank degradation and accelerated erosion. This usually leads to lack of cover, growth of invasive plants, reduction in pool habitat, and increased fine sediment input and accumulation, which all negatively affect salmonids. Projects that improve riparian habitat conditions for salmonids, such as riparian plantings or side channel construction/reactivation, may utilize the bank stabilization techniques listed below. For a detailed description of each technique refer to Integrated Streambank Protection Guidelines (Cramer et al. 2003).

All restoration/enhancement projects that employ bank stabilization need to have restoration as their primary purpose and need to address the cause of the habitat degradation. Streambank

stabilization cannot be the only proposed component, but rather a conservation measure applied to help a primary action like removal of bank protection and installation of riparian revegetation to succeed.

a. **Bank Protection Engineered Log Jams**: The goal of bank protection ELJs is to protect a section of natural stream bank that may be vulnerable to accelerated erosion resulting from project activities or existing infrastructure that have altered the natural stream flow. Bank protection ELJs can be placed intermittently as a series of flow defectors or as a continuous revetment (Herrera 2006b). Examples in the Pacific Northwest include the Elwha River in Washington and Johnson Creek in Portland, Oregon.
b. **Groins/Spur Dikes:** Groins are large roughness elements that project from the bank into the channel. Different from barbs, groins extend above the high-flow water-surface elevation. Usually they are constructed in a series to provide continuous bankline roughness.
   Groins must be constructed exclusively from wood with minimal anchor rock. Constructing less permanent (compared to rock) wood groins will ensure that in the long-term the groins do not interfere with natural river dynamics and provide maximal habitat.
c. **Barbs/Vanes/Bendway Weirs:** Barbs, vanes, and bendway weirs are low-elevation structures that project from a bank into the channel. They are angled upstream to redirect flow away from the bank. They increase channel roughness and reduce water velocity near the bank. Barbs have to be constructed from wood with minimal anchor rock. Wooden barbs within the active river channel may be used to allow soft bank treatments such as reshaping and native plantings to mature. Constructing less permanent (compared to rock) wood groins will ensure that in the long-term the groins do not interfere with natural river dynamics and provide maximal habitat.
d. **Rootwad Toes:** Rootwad toes are structural features that prevent erosion at the toe of a streambank. The toe refers to that portion of the steambank that extends from the channel bottom up to the lower limit of vegetation. Rootwad toes can provide the foundation for soft upper-bank treatments such as bank reshaping and soil reinforcement. Rootwad toes provide better fish habitat and have a shorter life span than rock toes.
e. **Bank Reshaping:** Reducing the angle of the bank slope without changing the location of its toe. However, the toe may be reinforced with rootwads or coir logs.
f. **Soil Reinforcement/Soil Pillows:** Soil layers or lifts encapsulated within natural materials. Often the lifts are used to form a series of stepped terraces along the bank which then are planted with woody vegetation.
g. **Coir Logs:** Coir (coconut fiber) logs are long, sausage-shaped bundles of bound-together coir. They are commonly used as a temporary measure to stabilize the bank toe while riparian vegetation grows.

1.3.5 The PSNERP Actions

Duckabush River Delta Restoration

The action would restore the natural geomorphology to the Duckabush River delta wetlands by removing major roadway obstructions, excavating channels, and removing fill. The action would realign Highway 101 across the estuarine delta to restore tidal connection to the estuary. A surface street crossing (Shorewood Road) and adjacent fill at a distributary channel (Pierce Slough) would also be removed. Multiple tidally influenced distributary river channels would be reestablished, and blind tidal channels would be excavated within the marsh areas. Figure 1 displays the restorative actions accompanying the relocation of the Highway 101 causeway.



Figure 1. Duckabush Causeway Replacement and Estuary Restoration, concept at 10 percent design.

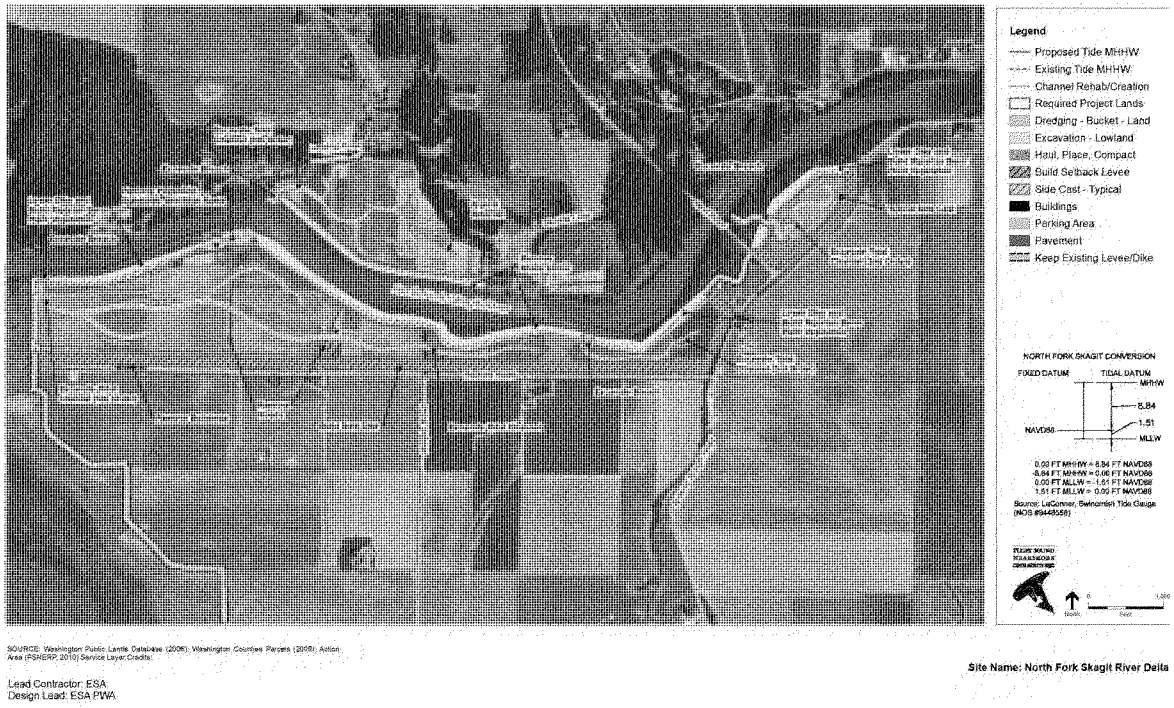
Table 1 summarizes the actions comprising the Duckabush River Estuary Restoration Action, and the extent of area affected by those actions. Completing all elements of the project will require up to three years. Work in the water will be constrained to the period between July 16 and August 31 of each year of construction.

Table 1. Key Design Elements—Duckabush River Delta Restoration

Item	Description of Item	Approx. Quantity
Roadway Removal	Remove 3,300 LF of Hwy 101 embankment including removing 1 culvert, approximately 300 feet of Duckabush Road, and 150 feet of Shorewood Road and culvert	3,750 LF
New Roadway	Build 2,100 feet of new highway including 2 culvert replacements, 150 feet of Duckabush Road, and 80 feet of new Shorewood Road	2,330 LF
Bridge Removal	Remove two existing Hwy 101 bridges	970 LF
New Bridges	Build one 1,100-foot bridge (8 spans at 138 feet) Build 100-foot bridge approach at Duckabush Road	1,200 LF
Shorewood Road	70-foot bridge at Shorewood Road	70 LF
Overhead Power	Relocate to new alignment	
Distributary Channels (large)	670 feet of north channel connection to the mainstem of Duckabush River and 460 feet of south channel connection to mainstem	1,130 LF
Distributary Channels (large)	1,900 feet of Pierce Slough reconstruction; 2,000 feet of other tidal channels	3,900 LF
Fill Removal	Remove training berms along river (0.7 acre), road embankment and roads (3.3 acres), and developed areas (2.5 acres)	6.5 acres

North Fork Skagit River Estuary Restoration

A brief description of the project is included in the Skagit Chinook Recovery Plan (SRSC and WDFW 2005). The proposed action will restore the riverine floodplain and tidal connectivity along the lower reach of the North Fork of the Skagit River. This will require constructing a new flood protection dike further inland. The existing dike would be lowered and selectively breached to allow inundation of the estuarine emergent marsh and sustain back channel habitat. Forested floodplain habitat would be created along the lowered dike adjacent to the mainstem river channel. Please see Figure 2 for a conceptual overview of the action at 10 percent design.



SOURCE: Washington Public Lands Dataframe (2006); Washington Counties Parcels (2005); Action Area (RSNERP, 2010) Service Layer Credits:

Lead Contractor: ESA
Design Lead: ESA PWA

Figure 2. North Fork Skagit River Delta Restoration, concept at 10 percent design

Table 2. Key Design Elements—North Fork Skagit River Restoration

Item	Description of Item	Approx. Quantity
Lower Levees and Build Riparian Berm	Excavate lowlands to lower 15,691 LF of existing levee to elevations similar to natural levees (13.5 ft MLLW, 12 ft NAVD 88 on the inboard side of the site, sloping down to 10.5 ft MLLW, 9.0 ft NAVD 88 on the main channel bank); Excavated material to be placed landward of existing levee to create 15,130 LF of floodplain berm approximately 100 to 150 ft wide (width to be determined by amount of material available) with the exception of 10,260 CY that will be used to block existing distributary channel west of Browns Slough Road	211,820 CY
Excavate Breaches in Lowered Levee	Excavate lowlands to breach lowered levee in 4 locations. Breaches will be constructed to dimensions of 5th order channel; assume 50-foot wide benches at 7 ft NAVD88 (8.5 ft MLLW) installed on either side of the breach. At the end of the 50 ft bench, 10H:1V slopes extend up to between 9 .0 and 11.0 ft. This section results in an excavation of 45 CY/LF (at 9.0 ft NAVD88 top elevation) to 79 CY/LF (at 11.0 ft NAVD88 top elevation)	29,720 CY
Excavate Tidal Channel Network	Excavate 19,617 LF of tidal channels and sidecast generated material adjacent to the channels to create low berms that will support a riparian corridor. Excavation includes: 2,349 LF of second-order channel; assume 3 ft bottom width at elevation 2.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 6,953 LF of third-order channel; assume 3 ft bottom width at elevation 0.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 7,702 LF of fourth-order channel; assume 3 ft bottom width at elevation -2.0 ft, 3H:1V sideslopes, and average surface elevation of 6.5 ft 2,613 LF of fifth-order channel; assume 3 ft bottom width at elevation -5.0 ft, 5H:1V sideslopes, and average surface elevation of 6.5 ft	179,315 CY
Block Distributary Channel	Place excavated material from levee lowering to block distributary channel located 2,650 ft downstream of Best Road bridge; assume 158,240 SF area with an average depth of 1.75 ft	10,260 CY

Item	Description of Item	Approx. Quantity
Remove Shore Armor	Remove 16,140LF of riprap armoring from existing levee (13,000 LF along south bank, 3,140 LF along north bank); assume entire length of levee is riprap composed of average of 5 ft height and 3 ft wide, with a density of 1.5 ton/CY	13,400 tons
Remove Buildings	Remove 17 buildings distributed throughout the project area including Blake's Resort and along Rawlings Road within the proposed levee lowering footprint; approximate area calculated from GIS	45,024 SF
Remove Pavement and Boat Ramp at Blake's Resort	Remove pavement at Blake's Resort; approximate area calculated from GIS Remove boat ramp; assume 100 ft x 300 ft	139,906 SF 30,000 SF
Remove Roads	Remove pavement from roads in newly setback area between lowered levee and new flood risk management levee; approximate area calculated from GIS	104,353 SF
Build New Levee	Construct new flood risk management levee along Rawlins Road, Browns Slough Road- Fir Island Rd, and Moore Road. Assume 11,970 LF with average select fill of 40 CY/LF and typical surface elevations between 7.0 and 6.0 ft NAVD88	478,800 CY
Plant Vegetation	Plant riparian vegetation along slopes of lowered natural levee and sidecast berms and along realigned levee on Rawlins Road, Brown's Slough Road, and Moore Road. Assume 100 ft wide along 15,691 LF of lowered levee and 11,970 LF of new levee	62 AC (approx.)

The entire project will require one to two years to complete. In water work will be constrained to the period between June 15 and August 31 of each construction year to avoid exposure of vulnerable life stages of listed salmonids.

Nooksack River Delta Restoration

This action removes levees, roads, and other barriers to restore hydraulic and sediment processes throughout the Nooksack River delta. Project elements would restore fluvial processes and enhance tidal hydrology to both the east (Nooksack River) and the west (Lummi River) sides of the delta; restore formerly drained and filled channels and sloughs through excavation; remove and/or relocate levees and berms to increase floodplain inundation and allow for channel

migration, and restore sediment dynamics; and modify existing roads and other infrastructure such as bridges. The entire action will require two to four years of construction to complete. Work in the water will be constrained to the period between June 15 and August 15 of each construction year.

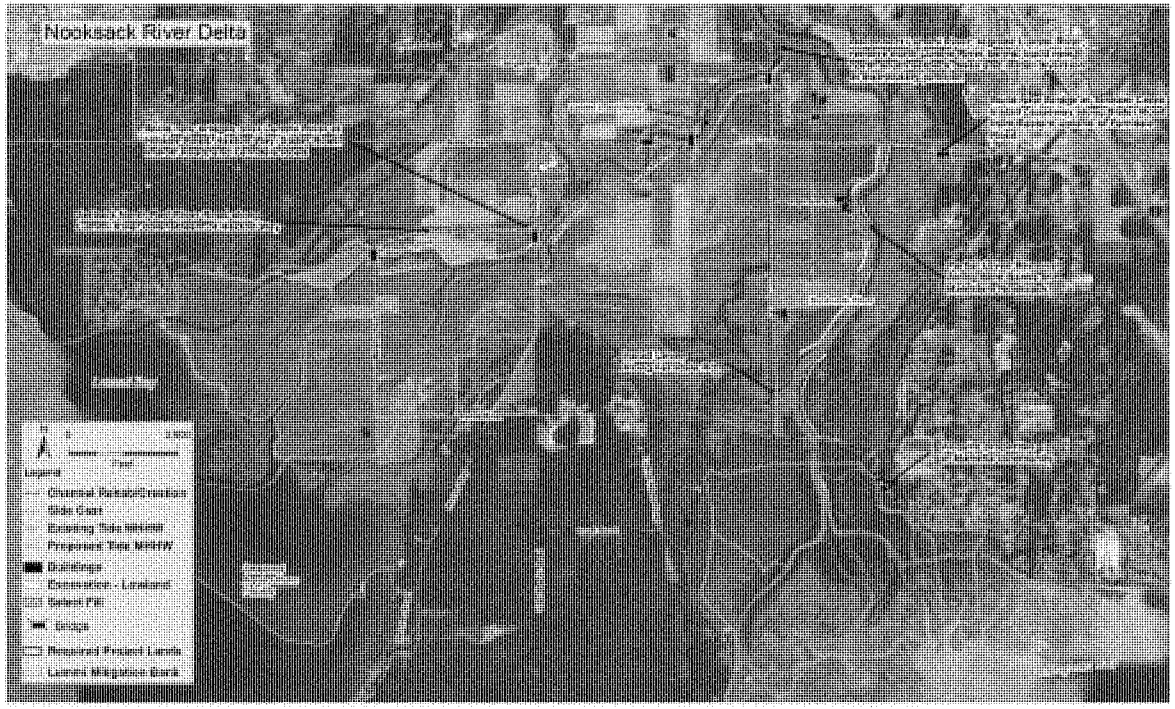
Table 3. Key Design Elements—Nooksack/Lummi Rivers Restoration

Item	Description of Item	Approx. Quantity
Nooksack River		
Install New Setback Levee and Relocate Ferndale Road	Set back right bank levee to Ferndale Road alignment between Slater Road and Marine Drive. New levee will be 12,633 LF with a typical section of 600 SF. Will include new paved road on	280,750 CY
Remove Portions of Existing Levees on Both Banks	Remove approximately 60 percent of right and left bank dikes from the Slater Road to near Marine Drive. Total length of 12,263LF.	75,450 CY
Install Log Jams in Mainstem Nooksack	Install large wood structures within Nooksack mainstem to assist geomorphic response of the river in concert with setting back the levees (location to be determined)	3 structures
Lummi River		
Install New Water Control Structure at Confluence	Upstream Lummi River connection to Nooksack River to be regulated via an engineered diversion structure that will be designed during PED. This structure is intended to facilitate transfer of freshwater and sediment to the Lummi River, while preventing avulsion of the mainstem to the west.	1 EA
Regrade Lummi River Channel and Berms. Remove North Red River Road West of Haxton	-Regrade existing Lummi River channel to install 0.04% bed slope and larger channel cross section to better match invert to water surface elevation of the Nooksack River, increase conveyance capacity, and create surface to encourage geomorphic processes. -Regrade would occur over the upper 9,980 LF of the channel, with a typical section of 285 SF in the upper 5,000 LF and 80 SF in the lower 4,890 LF.	67,300 CY
	Remove existing berm and road along north side of Lummi River west of Haxton Way. Length of berm to be removed and associated volumes are: west to Hillaire=3,843 LF; 10,659 CY; Hillaire to Haxton=5,927 LF; 13,017 CY; Haxton to Slater=1,981	30,900 CY
Build New Setback Levees[1]	Install setback levee on south side of the Lummi River channel between Haxton and Ferndale. Length is 11,232 LF with typical section of	72,800 CY
	Install setback levee on the north side of the Lummi River channel from the valley margin to the Ferndale Rd and realign North Red (Lummi) River Road away from channel. Length is 23,025 LF with typical sections varying from 135 SF/LF to 432 SF/LF based on levee heights 5 to 8 feet.	279,500 CY

Item	Description of Item	Approx. Quantity
Transportation Improvements		
Modify Slater Road at Lummi River	Remove a portion of the existing roadway.	450 LF
	Raise Slater Road (build new roadway)	200 LF
	Build new bridge (two 125-foot spans) over Lummi River	250 LF
Modify Slater Road at Tennant Creek	Add span on Tennant Creek to allow 100-year flow to pass below the two bridges.	390 LF
	Install elevated causeway along Slater from eastern upland to	5,600 LF
Modify Haxton Way	Build new bridge (three 150-foot spans) over Lummi River	450 LF
	Install new road approaches	200 LF
	Remove a portion of the existing roadway	1,300 LF
Re-align North Red River Road and Haxton Way	New road on top of setback levees (30-foot width)[1]	9,216 LF
Modify Hillaire Road at Lummi River	Build new bridge (three 150-foot spans)	450 LF
	Remove a portion of the existing roadway	575 LF
	Build new roadway	200 LF
Modify Imhoff Road at Lummi River	Build new bridge (two 125-foot spans)	250 LF
	Remove a portion of the existing roadway	400 LF
	Build new roadway	150 LF
Modify Ferndale Road at Lummi River	Build new bridge (two 125-foot spans).	250 LF
	Remove a portion of the existing roadway	650 LF
	Build new roadway[1]	12,200 LF

[1]Necessary to protect adjacent land from additional flows that are diverted into the Lummi River from the Nooksack River.
[2]Necessary for emergency evacuation due to removal of levees along the Nooksack River.

Figure 3. Nooksack River Delta Restoration Concept, 10 percent design



1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). Although three actions covered in this opinion were submitted to NMFS as a batch, each occurs in a discrete location in Puget Sound. Therefore each action has a discrete action area. A common element of all three actions is the corridor-based aspect to the action areas. Each action area track the effects of the restoration activities for each action. These include hydraulic modifications to enable each river greater access to its historic floodplain and the restoration of historic channels of the river to restore a more natural hydraulic regime for each delta.

Duckabush River Delta Restoration

The proposed action is located in the Duckabush River and wetlands at the Highway 101 crossing, near the town of Duckabush, Jefferson County, Washington 47.649175 N latitude, -122.934644 W longitude. The action area for the Duckabush River Delta Restoration action is defined by actions having environmental effects from Highway 101 removal and replacement with an elevated structure, among other things. All effects of other elements of the proposed action will manifest in a polygon defined in the 3500-foot corridor of the existing Highway 101 through the Duckabush Estuary bounded by Robinson Road to the North and the beach of the southern-most distributary to the south. The corridor includes approximately 300 feet of estuary East of and parallel to the existing highway, and 600 feet of land West of and parallel to the existing highway. The 600 foot portion of the corridor west of the existing highway includes the location of the planned bridge and new approaches for Highway 101, the road removal elements at Duckabush and Shorewood Roads, channel rehabilitation for each of the distributaries, and berm removal within the estuary and along the Duckabush River. See Figure 1 for a complete depiction of the larger area containing the action area.

North Fork Skagit River Delta Restoration

The proposed action is located in the North Fork Skagit River near Mt. Vernon, Skagit County, Washington 48.35825 N latitude, -122.4355 W longitude. The action area for the North Fork Skagit River Delta Restoration is defined mainly by actions removing existing berms and levees, restoring relict off-river channels, and is bounded firmly by setting-back of the levee on the south bank of the river. This includes the River corridor and a portion of the floodplain adjacent to the River from the junction of Polson and Fir Island Roads (on the south side of the River) to the mouth of the river at the Skagit River Estuary. An extensive majority of the work under this action occurs between the location of the new setback levee, south of the river. However, the action area includes a small area of new channel on the north bank of the river between Skylda Lane and Landing Road. See Figure 2 for a complete depiction of the area containing the action area.

Nooksack River and Lummi River Delta Restoration

The proposed action is located in the Nooksack and Lummi Rivers near Ferndale, Whatcom County, Washington 48.826772 N latitude, -122.593378 W longitude. The effects of the action

will be collectively diffuse as they are several and scattered along the banks of both rivers from their confluence near 5059 Ferndale Road downstream to near the to the mouth of each river just upstream from their deltas on Puget Sound. See Figure 3 for a complete depiction of the area containing the action area.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

None of the three actions batched for this consultation are likely to adversely affect SRKW or its critical habitat. There is no SRKW critical habitat in Hood Canal south of the Hood Canal Bridge and therefore the Duckabush action will have no effect on SRKW critical habitat. The analysis is found in the "Not Likely to Adversely Affect" Determinations section 2.11.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[2]

[2] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the range-wide status of PS Chinook salmon and HC summer-run chum salmon, and aquatic habitat at large, is climate change. Salmon throughout Washington are likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (Battin et al 2007). While the intensity of effects will vary by region, climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al 2007), NMFS anticipates salmonid habitats will be affected. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathe 2010) – changes that will shrink the extent of the snowmelt-dominated habitat available to salmon. Such changes may restrict our ability to conserve diverse salmon life histories.

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average air temperatures in Washington State are likely to increase 0.1-0.6°C per decade (Mote and Salathe 2010). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms,

changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua 2009). The largest driver of climate-induced decline in salmon populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al 2007).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmon mortality. Higher ambient air temperatures will likely cause water temperatures to rise. Salmon require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua 2009).

In marine habitat, effects of climate change include: increased ocean temperature, increased stratification of the water column, ocean acidification, and changes in intensity and timing of coastal upwelling. These continuing changes will alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids. A mismatch between earlier smolt migrations (due to earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Increased concentration of CO_2 reduces the availability of carbonate for shell-forming invertebrates, including some that are prey items for juvenile salmonids.

Climate change is expected to make recovery targets for these salmon populations more difficult to achieve. Habitat action can address some of the adverse impacts of climate change on salmon. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (Battin et al 2007).

2.2.1 Status of Listed Species

Table 4, below provides a summary of listing and recovery plan information, status summaries and listing factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available at the NMFS West Coast Region Website (http://www.westcoast.fisheries.noaa.gov/).

Table 4. Status of the Species in this Consultation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05	Shared Strategy for Puget Sound 2007 NMFS 2006	Ford 2011	This ESU comprises 22 populations distributed over five geographic areas. No trend was notable for total ESU escapements; escapement trends vary from decreasing to increasing among populations. Median recruits per spawner for the last 5-year period (brood years 2002-2006) is the lowest over any of the 5-year intervals. Many of the habitat and hatchery actions identified in the Puget Sound Chinook salmon recovery plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Hood Canal summer-run chum	Threatened 6/28/05	Hood Canal Coordinating Council 2005 NMFS 2007	Ford 2011	This ESU is made up of two independent populations in one major population group. The spawning abundance of this ESU has clearly increased since the time of listing, although the recent abundance is down from the previous 5 years. However, productivity in the last 5-year period (2002-2006) has been very low, especially compared to the relatively high productivity in the 5-10 previous years. Since abundance is increasing and productivity is decreasing, improvements in habitat and ecosystem function likely are needed.	• Reduced floodplain counectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality
Puget Sound steelhead	Threatened 1/5/06	In development	Ford 2011	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Most populations within the DPS continue downward trends in estimated abundance, a few sharply so. Only three winter-run steelhead populations examined exhibit positive growth rate. Trends could not be calculated for the South Puget Sound Tributaries winter-run population. Little or no data is available on summer-run populations to evaluate extinction risk or abundance trends.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, bank hardening, and channelization

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2.2.2 Status of Critical Habitat

In this section we review the status of designated critical habitat for Puget Sound Chinook, HC summer-run chum, and Puget Sound steelhead. These primary constituent elements (PCEs) are features essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). Thus, while critical habitat must contain one or more PCEs, this does not mean that all PCEs are present or that the PCEs present are functioning optimally.

Puget Sound Recovery Domain
Critical habitat has been designated throughout Puget Sound and in the action area for PS Chinook salmon, HC summer-run chum salmon, and Puget Sound steelhead. Notable tributary river basins in and near the Puget Sound basin include the Nooksack, Skagit, Stillaguamish, Snohomish, Lake Washington, Green, Puyallup, White, Nisqually, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers.

Freshwater Primary Constituent Elements. Water quality is a PCE of spawning, rearing, and migration habitats. In many areas, water quality is affected by sediment load. Landslides can occur naturally in steep, forested lands, and inappropriate land use practices combined with severe storms in some places have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unsurfaced roads has also contributed to stream sedimentation. Historical logging removed most of the riparian trees near many stream channels. Water quality in many locations of CH is also impaired by warm temperature. Agricultural and urban conversion has permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade. Impervious surface in urban and urbanizing watersheds has interrupted hyphoreic processes that would otherwise allow cool water recharge, thus stormwater returns to streams are warmer, and also carry a variety of chemical pollutants. Lack of riparian trees has also decreased, and in many areas precluded, large wood recruitment (NMFS 2007).

Habitat complexity and floodplain connectivity are PCEs of spawning and rearing habitat areas. These PCEs have been modified or eliminated by diking, agriculture, revetments, railroads and roads, especially in lower river reaches. Significant loss of secondary channels in major valley floodplains occurs throughout this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (Spence 1996, NMFS 2007).

Severe alteration of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (NMFS 2007).

In some rivers, peak stream flows are believed to have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in (NMFS 2007).

Marine and Estuarine PCEs. The nearshore marine habitats which are a PCE for juvenile outmigrant salmonids have been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand and gravels (NMFS 2007).

Adverse water quality of the near-shore environment occurs some years in the southeastern areas of Hood Canal, when natural circulation is altered and marine oxygen is depleted in late summer, causing significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. In addition to higher loading of nitrogen from alders growing along many streams, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (NMFS 2007) (Hood Canal Coordinating Council 2005).

In summary, salmon critical habitat throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), altered riparian vegetation, wetland draining and conversion, dredging of spawning and rearing habitats, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, diversity, as well as altered flow, temperature, sediment load and channel stability are common limiting factors in areas of salmon critical habitat. While PCEs are degraded throughout much of the designated CH of the domain, many areas are still ranked as providing high conservation value due to the important role that those locations serve in meeting salmonid life history needs, or due to the relative importance of the populations that rely on those locations.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section

7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Duckabush River Delta

The Duckabush River is one of several major river systems in the Hood Canal Subbasin draining the east slope of the Olympic Mountains to Hood Canal. The broad river delta fans out into the canal on the south side of Black Point Peninsula. The Highway 101 causeway crosses the delta, spanning the main channel and a northern distributary channel via bridges. The area south of the river delta is primarily a basaltic shoreline with a few pocket beaches. The river and the feeder bluff on the side of Black Point Peninsula provide abundant sediment for the drift cell that begins at the central portion of the delta and continues north to the cuspate spit at Quatsop Point. Residential development is concentrated just south of the delta and on the north and east sides of Black Point

The Duckabush River opens to a wide valley within the action area. The river is contained within a single channel through the site before emptying into the marsh and submerged marsh outboard of the site. The historic northern arm of the river has been blocked, is aggraded, and is a dead-end channel in the middle portion of the site. Both channels are tidally influenced and pass under bridge crossings. Training berms are in place at the southern arm, just upstream of the Highway 101 crossing, to control lateral movement of the channel. The northern channel branches to form smaller dead-end channels upstream of Highway 101, and receives freshwater flow from a connection to the small tributary that crosses Shorewood Road.

Pierce Slough, located at the northwest corner of the site, is partially disconnected from tidal flows by the culverted Highway 101 crossing. A remnant tidal channel network exists outboard of the highway between the north and south channels. The northern tidal channel network appears to have aggraded over time, though it is partially present today.

Highway 101 bisects the Duckabush River in its estuary in Hood Canal. Although the estuary at the mouth of the Duckabush River is in relatively good condition, the fill that makes up the road bed of Highway 101 blocks natural estuary function, simplifies the distributary channels and limits habitat available to summer chum. Additionally, blocking distributaries has been shown to increase predation on juvenile summer chum by forcing them into the mainstem river channel during outmigration. Without redesigning Highway 101 across the Dosewallips and Duckabush Rivers to improve estuary functions, habitat restoration of critical summer chum habitat will be limited. Habitat protection and restoration elsewhere in the system would not likely be sufficient to overcome the negative impacts to the estuaries caused by the highway (PSNERP 2012).

Listed Species in the Action Area

The Duckabush River is used by Hood Canal Summer-run chum salmon. The NMFS identified two independent populations of Puget Sound Chinook salmon within Hood Canal: the Skokomish River and Mid-Hood Canal Rivers (Dosewallips, Duckabush, and Hamma Hamma) (Ruckelshaus et al. 2006). The greatest abundance of adult PS Chinook salmon along in the Mid-

Hood Canal group occurs from early August to October as the adults return from the ocean to their natal streams and rivers.

Generally, PS Chinook salmon juveniles emigrate from freshwater natal areas for estuarine and nearshore habitats from January through April as fry, and from April through early July as larger subyearlings. By July juvenile PS Chinook salmon are sufficiently large to no longer orient to the shoreline and thus would be less likely to be caught during beach seine surveys. Juvenile PS Chinook salmon are likely present outside of the action area during the in-water work window, in deeper, offshore waters.

Steelhead in the Duckabush River are part of the West Hood Canal Winter-Run Steelhead demographically independent population (DIP) (PSTRT 2009). The West Hood Canal Winter-Run Steelhead DIP combines winter steelhead from the Hamma Hamma, Duckabush and Dosewallips rivers, and Quilcene River/Dabob Bay. Historic escapement data is lacking for this DIP, but based on recent stream surveys, the population most likely consists of only a few hundred fish. In response to the low estimates, the Hood Canal Steelhead Project was initiated in 2007 by NOAA Fisheries. The goals of the project were to access the benefits of conservation hatchery programs, provide guidance to fisheries managers about steelhead hatchery practices and recovery policies, and attempt to recover three Hood Canal steelhead populations (Duckabush, Dewatto and South Fork Skokomish). The project is monitoring 8 streams within Hood Canal that are divided between supplemented and control streams. The Duckabush is one of three supplemented streams and receives hatchery smolts and adults that are the progeny of excavated natural origin steelhead redds from the Duckabush (Weinheimer 2014).

The areas that most directly affect survival and persistence of these salmonid populations are the estuary and immediate nearshore marine habitat. Thus, loss of channel complexity, altered sediment dynamics, riparian degradation, estuarine habitat loss and degradation from diking, filling, log storage, and road causeways, and alteration of the nearshore environment from shoreline development are factors limiting the ESU's survival. Indications of these types of conditions are present in the action area owing to the channel simplification caused by the present location of US Highway 101 and its construction on fill placed through the corridor directly over the estuary.

North Fork Skagit River Delta

The north fork of the Skagit River diverges the Skagit River near Skagit City, Washington for the last few miles of its oceanward flow. Both forks end at Skagit Bay on the eastern shore of Puget Sound across from Whidbey Island. Extensive diking of the North Fork Skagit River has caused substantial loss of estuarine connectivity. The proposed restoration would set back flood protection dikes on both sides of the North Fork, from the former inlet of Dry Slough to the western terminus of the dike system near Rawlins Road.

Historically, estuarine wetlands were extensive in the floodplains of the Skagit River, accounting for at least 27 percent of land area (Collins 1998). The Skagit River delta also had extensive freshwater wetlands covering a further 22 percent of the land area (freshwater wetlands include riverine tidal areas in which tidal backwater augmented the effects of flooding). The delta had

numerous distributary and blind tidal channels which, because of the delta's diverging-spreading form, were dominated by estuarine channels. Deposition patterns associated with these channels created topographic gradients. The highest areas occur upstream where there was initial deposition of coarser material from fluvial sources. Elevations lowered and the sediment became finer southward as estuarine processes dominated. There was also an elevation gradient laterally with distance from the distributary channels. Coarser, better drained soils were found in the natural levees that line the banks of the distributary channels, creating distinctive riparian corridors in the deltas. Typically, small channels would have run parallel to the main channel behind the natural levee.

Presently, The North Fork levee action area lies on a salinity gradient from estuarine-emergent marsh, to estuarine-scrub-shrub, to forested floodplain zones (Collins 2000). While salinity and elevation gradients still exist in the action area, much of the associated habitat has been lost. Only a discontinuous narrow strip of riparian floodplain now lies between the channel and the dike. This strip is about 500 feet wide on either side of the North Fork Bridge but narrows significantly downstream. The floodplain disappears altogether for long stretches where the dike is adjacent to the channel. In several of these locations the dike has been armored with riprap. The remnant riparian floodplain has been significantly narrowed and fragmented. The only remaining channels associated with the floodplain are found adjacent to the North Fork Bridge and appear to have been truncated by diking.

There are significant areas of emergent marsh, scrub-shrub and forested floodplain west of Rawlins Road. Continuing this band of habitat eastward through the site would significantly improve the ecosystem connectivity within North Fork floodplains, tidal channels, and estuarine wetlands. This would increase the migratory conditions for salmonids between the Skagit River and nearshore marsh habitats eliminated with the construction of the dikes. It would also restore landscape-scale ecological processes on Fir Island as the health of a coastal marshland habitat is dependent upon an adequate supply of sediment and nutrients, which was eliminated with construction of the dikes.

Listed Species in the Action Area

The Skagit River watershed is the largest within the Puget Sound. Its large size features relatively diverse sub-watersheds that support six independent populations of Chinook salmon: Lower Sauk, Upper Sauk, Suiattle, Upper Cascade River, Lower Skagit, and Upper Skagit populations (PSTRT 2006). No other river within Puget Sound supports more than two populations. Individually and collectively, the Skagit Chinook salmon populations are essential to the survival and recovery of the ESU because they provide vital contributions to its abundance, productivity, diversity and spatial structure.

In all, more than a fourth of the ESU's populations reside within the Skagit River system. The six Skagit River populations have been relatively uninfluenced by hatchery releases, as compared to most other ESU populations, and represent a significant portion of naturally produced fish within the ESU (Myers et al. 1998). Collectively, the Skagit Chinook salmon populations (in addition to the North Fork Stillaguamish population), make up one of six genetic groups within the ESU. Marshall et al. (1995) assigned all Skagit and North Fork Stillaguamish

Chinook salmon stocks to the same Genetic Diversity Unit based on life history, genetic, and habitat similarities within the Skagit and North Fork Stillaguamish River basins. There is one hatchery in the Skagit River system. As such, these populations represent a valuable reserve of genetic diversity for the ESU.

Nooksack and Lummi River Deltas

This action area is centered on the Lummi Reservation north of Bellingham in the San Juan/Georgia Strait Subbasin. It encompasses nearly all of the Nooksack and Lummi River Estuaries below Ferndale, Washington. The mainstem Nooksack River currently flows into Bellingham Bay on the east side of the Lummi Peninsula, and the alignment is enforced with levees.

Nooksack River and has also been separated from tidal influence by the levee system. The Lummi River has full tidal access but is essentially a blind channel because it is separated from the mainstem Nooksack River by a levee, and only receives intermittent mainstem flow through the aforementioned culvert. The Lummi River receives freshwater inflows from Shell Creek, which drains portions of the City of Ferndale to the north. Most of the former western delta wetlands are separated from tidal influence by a levee system along the Lummi River and levees and tide gates in other areas. Forest cover has been almost entirely eliminated from the western delta. Riparian forest along the mainstem and forested areas within the progradating delta occur on the eastern portion of the delta.

Collins and Sheikh (2005) estimated general losses of wetland types using mapping from 1880 and 1998. These estimates indicate substantial losses of palustrine (freshwater) and estuarine wetlands. The modern "winter inundation area" is around five percent of the historical condition, and "summer inundation" about one percent of the historical area. The area of estuarine wetland is estimated to be about 30 percent of the historical condition (Collins and Sheikh 2005).

Listed Species in the Action Area

The Nooksack River is used by Puget Sound Chinook salmon and Puget Sound steelhead. There are two populations of listed Chinook (North and South Fork) with early-run timing. A third population is a hatchery-bred fall run that is not part of the listed ESU but is derived from native stock (Lummi Nation 2005).

The North/Middle Fork and South Fork spring Chinook populations are at extreme high risk due to their low numbers and the low productivity of freshwater habitat. Estimates of historic Chinook abundances are an average of 26,000 and 13,000 respectively for the North Fork and the South Fork populations. Now, natural-origin Chinook return in the low hundreds, averaging 170 (North/Middle Fork) and approximately 80 (South Fork) fish in recent years. There are seven significant habitat factors limiting the Chinook: Instability of channel in the upper and middle portions the Forks; Increased sediment coming from natural and human causes, and changes in how that sediment is transported through the system; Loss of logs and other structures in the Forks and their tributaries that create pools and rearing places for the fish; Bank armoring mostly in the South Fork and mainstem that constrain the river and eliminate side channels where fish rear and could seek refuge during floods; Obstructions that block fish from key

habitats; Changes in the river flow and temperature. The temperature and low summer/fall flows in the South Fork are viewed as a significant challenge to the long term survival of that population; and Changes along marine shorelines in Bellingham Bay and in nearshore areas have affected Nooksack and other Puget Sound populations that use these waters.

Primary Constituent Elements of Critical Habitat in all three Action Areas

The PCE of most concern in these action areas is the estuarine PCE. The estuarine PCE consists of areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Because estuarine hydraulics are constrained by a variety of stream crossings, berms, and levees in all three systems considered in this consultation, the processes that support transactions between salt and freshwater are impaired. This impairment decreases several factors in each action area that would otherwise fully support estuarine life histories of the affected populations. Specifically, these areas cannot optimally support physiological transition to salt water and do not provide as much available cover, distributary connectivity, and juvenile salmonid forage production. Furthermore, the lack of space from floodplain and distributary connectivity constrains space needed to increase carrying capacity of the affected areas.

The restoration actions that are the subject of this consultation would address these limitations directly and completely in each action area.

2.4 Effects of the Action on Listed Species and Designated Critical Habitat

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. For the following effects discussion "salmonids" stands for listed salmonids these actions are likely to adversely affect, including PS Chinook salmon, Hood Canal summer-run chum salmon, and PS steelhead.

As stated in the Description of the Proposed Action (Section 1.3), programmatic consultation (and accompanying programmatic consideration of the effects of the action) works well when the program consists of applying standardized practices and prescriptions are applied to the same activities, across similar landscapes. Consistently applying standardized practices where needed renders the environmental outcomes of those activities readily predictable.

Predictable environmental outcomes makes for reliable assessment of the likely effects of individual actions carried out under the programmatic review, such as the three PSNERP actions that are the subject of this consultation. As such, the following section extensively excerpts the relevant portion of the effects analysis presented in NMFS No. NWR-2008-3598, and presents

the likely environmental results of the relevant categories of restoration activities and their accompanying conservation or minimization measures included in each of the PSNERP actions. Section 2.4.2 does the same for the Critical Habitat analysis. Finally, Section 2.4.3 presents the ecological outcomes of removing certain process-limiting structures from each of the three PSNERP action areas. Specifically, Section 2.4.3 discusses the likely restoration outcomes for each action in terms of restored process and their bearing on habitat function for fish use.

2.4.1 Effects of the Restoration Activities Common to the three PSNERP Actions

The nine restoration categories from NMFS No. NWR-2008-3598 are designed for the sole purpose of improving habitat conditions for listed salmonids. As a general matter, restoration activities developed under PSNERP will cause immediate and long-term improvements to the processes that create and maintain habitat for listed species and incrementally result in improvements to abundance, productivity, and the spatial distribution of all listed salmonids.

Aside from long-term benefits, the actions will have some construction-related, short-term, minor, unavoidable, adverse effects like increased turbidity and injury or death of individual fish from work site isolation that requires fish capture and handling. NMFS has conducted hundreds of individual consultations on each activity type over the past ten years. The knowledge gained from these individual consultations has been applied to compose the activity design criteria and conservation measures for this consultation.

In NMFS No. NWR-2008-3598, NMFS determined that quantifying the specific number of individuals that would be injured or killed by short term construction effects (excluding work area isolation) actions taken under the programmatic was not possible without site-specific information. Similarly, as the three PSNERP actions under consultation here are conceptual in design at the time of consultation, determining a specific number of individual fish that would be injured or killed during construction of the restored areas is impossible to quantify from conceptual design information. However, the value of programmatic consultation is the ability to group categories of actions that will be carried out under carefully prescribed conditions, such that their results are predictable, repeatable, and constrained, no matter where they occur. Predictability and repetition of results enables NMFS to make larger scale, and longer term predictions about how those results will integrate with conditions under the environmental baseline given the backdrop of species and critical habitat status in the action area. As such, these factors enable NMFS to consult programmatically without the burden they might otherwise encounter created by uncertainty surrounding the locations and intensity of the effects of future projects, including the accrual of the benefits of habitat restoration where those activities occur.

Short-Term Effects of Construction Relevant to Every Activity Category

The COE proposes to implement conservation measures that would minimize the construction-related negative impacts. However, some negative impacts would be unavoidable.

Fish Capture and Handling during Worksite Isolation. Dewatering the work area is a conservation measure that is applied to reduce the risk of potential injury to salmonids associated with increased sedimentation and equipment operating in the channel. Restoration activities that

involve dewatering stream segments will follow the Dewatering and Fish Capture Protocol (Appendix A of NMFS No. NWR-2008-3598), which is designed to minimize impacts to salmonids from worksite isolation, mainly stranding, capture, handling and electroshocking. This conservation measure sets up a sequence of actions used to exclude fish from the work area. Generally, an upstream block net is set first then fish are seined downstream. After that the work area will be dewatered slowly over several hours. In areas where salmonid presence is likely, the project is left in a stable low flow condition overnight. During gradual dewatering, most fish are expected to voluntarily leave the worksite. Fish that get stranded or trapped will be removed with a sanctuary net to keep them in water at all times. Using electroshocking is proposed only when all other methods of removing fish have been applied.

The Dewatering Protocol directs that all fish capture operations will be conducted by or under the supervision of an experienced fishery biologist, and all staff working with the seining operation must have the necessary knowledge, skills, and abilities to ensure the safe handling of salmonids. Additionally, this Protocol directs that fish must be handled with extreme care and kept in water at all times during transfer procedures in order to prevent the added stress of an out-of-water transfer. The fish removed from the dewatered reach will be released as near as possible to the isolated reach in a pool or area that provides cover and flow refuge. Following the in-water work windows (Appendix B of NMFS No. NWR-2008-3598) further minimizes the risk to salmonids, because they are less likely to be present in the stream reach during the construction period.

Even with implementation of the Protocol and in-water work windows, there is a potential that a small number of juvenile salmonids or their prey will avoid being captured and relocated and may die because they remain undetected in stream margins under vegetation or gravels during installation of water diversions and dewatering of the stream channels. Adult and sub-adult salmonids, because of their larger size, cannot seek refuge in the gravel and are easier to detect and herd downstream. These larger fish are only very rarely expected to be exposed to stranding or electroshocking. Sub-adult salmonids, older than one year and generally larger than 150 mm (with variations depending on the species and population), like adults, cannot seek refuge in the gravel and are easier to detect and herd downstream. However, some sub-adults may hide under vegetation. Thus, they may be exposed to capture using dip nets during the dewatering process. Usually, sub-adults are successfully excluded from the construction area prior to electroshocking. Thus, some juveniles and sub-adults and very few adult salmonids are reasonably certain to hide in the gravel or under structural cover and may be injured or killed during capture and/or use of the electro-shocker.

Electrofishing is typically used as a last resort to remove fish from exposure to the construction effects. The process involves passing an electrical current through water containing fish to stun them, making them easier to locate and remove from the work area. The process of running an electrical current through the water can cause a suite of effects on fish ranging from annoyance or fright behavior and temporary immobility to physical injury or death resulting from accidental contact with the electrodes. The amount of unintentional mortality attributable to electro-fishing can vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician.

To minimize unintended negative effects, NMFS' electrofishing guidelines (NMFS 2000) will be followed in all projects employing electrofishing equipment. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing will be used only when other methods to eliminate salmonids from the work area have been exhausted or are not feasible. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Only direct current units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. When such low settings are used, shocked fish normally revive very quickly.

Because of their larger size and surface area exposed to the voltage, electrofishing can have severe effects on adult salmonids. Adverse effects include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Hollender and Carline 1994; Dalbey et al. 1996; Thompson et al. 1997). Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects electrofishing has on both juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 millimeters in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (Dalbey et al. 1996; Thompson et al. 1997; Thompson et al. 2008). McMichael et al. (1998) found a 5.1 percent injury rate for juvenile MCR steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988; Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current or low-frequency (equal or less than 30 Hz) pulsed direct current have been recommended for electrofishing (Fredenberg 1992; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992; Dalbey et al. 1996). Only a few studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996; Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

Isolation of the work site has the obvious effect of temporarily removing individual fish from an area in which they were expressing normal behavioral patterns and life histories. Such displacement can lead to higher energy expression as fish seek equilibrium and replace their previous feeding opportunity with a new one. Finally, the mechanical processes of using nets to move fish may cause net contact which also contributes to stress, although such short-term contact is less likely to cause injury or death.

Based upon the above information, NMFS conclude that the adverse impacts to adult salmonids from worksite isolation are limited to temporary displacement. Due to their size they are generally successfully seined out of the construction area. The effects on sub-adult salmonids, are limited to temporary displacement, seining and handling. Sub-adults generally cannot hide in the gravel and thus are easier to seine out. Should they still be in the construction area during gradual dewatering, they are easier to detect than juveniles and thus likely to be rescued with sanctuary nets. Juvenile salmonids (0+) are the only age class that is likely to experience effects from electrofishing and stranding in addition to temporary displacement, seining and handling.

Water Quality--Turbidity and Sediment Deposition. For restoration projects with an in-stream component the COE proposes to have the applicant propose if work in the wet or in isolation from the flowing water would result in less impact to salmonids. NMFS can then review the applicants reasoning in the SPIF and ask for adjustments in work site isolation plans, if necessary. Generally, activities that are conducted below the OHWL result in less turbidity if work is performed in isolation from the flowing water. However, there are cases in which negative impacts from turbidity are less when work is performed in the flowing water. These cases include work in gravel or bedrock substrate and work that has a very short in-stream work component, like placing individual LWD pieces.

The effects of increased suspended solids (SS) on salmonids depend on the extent, duration, timing, and frequency of increased SS at the place where it will occur (Bash et al. 2001) Depending on the level of these parameters, sedimentation can cause lethal, sublethal, and behavioral effects in juvenile and adult salmonids (Newcombe and Jensen 1996). Behavioral effects in response to elevated SS levels include avoidance, sub-lethal effects include reduction in feeding rates, stress, gill flaring, and coughing (Spence et al. 1996).

NMFS expect adults and sub-adults to leave areas with elevated levels of turbidity that would result in significant impairment of respiration and feeding. Thus, they would be mostly affected by the effects of temporary displacement, rather than the direct effects of exposure to increased turbidity. Juveniles on the other hand are more likely to seek cover, rather than leave, and, because they are less mobile, are more likely to be exposed to construction-related turbidity.

The summer in-water work windows are designed to reduce impacts on redds and limit exposure to juvenile salmonids, thus reducing the likelihood for adverse effects to the most vulnerable life history stages from increased sedimentation. However, sedimentation from natural causes, such as rainstorms and slope failure, is mostly correlated with high flow events that occur during winter. Increased sedimentation in the summer is thought to affect salmonids more severely than in winter because fish secrete less protective mucous during that time of year (Bash *et al.* 2001).

The disturbance of the stream bed associated with many restoration actions is likely to result in a second pulse of turbidity with high fall/winter stream flows and velocities. Again, the magnitude of this increase in turbidity is related to the composition of the substrate. Generally, the finer the substrate, the higher the delayed, construction related turbidity. This second increase in turbidity can occur when eggs are in the gravel.

Lapointe et al. (2004) conducted laboratory incubation experiments to test the relative sensitivity of incubating eggs to silt (diameter less than .063 mm) and sand. Their results showed that redds can be extremely sensitive to single digit and even less than one percent increases in silt deposition. Silt loadings over 0.5 percent are detrimental to survival if sand concentrations are above five percent (Lapointe et al. 2004). At 15 percent sand mean survival decreases from 60 percent to 20 percent as silt content increases from zero to four percent (Lapointe et al,. 2004). Wu (2004) used data from previous publications to develop a model to predict embryo survival as a function of parameters that influence the hydraulic gradient and substrate permeability (gravel shape, gravel size composition, sediment deposition, and sediment size distribution). Wu's (2004) results show for a given content of fine deposition an increasing survival rate with increasing sediment diameter. Thus, depending on the sediment and spawning gravel composition eggs may experience a reduced rate of hatching due to suffocation after mobilization of sediment during the first fall/winter rain events following project construction.

In summary, work with an in-stream component in streams with sandy and finer substrate is reasonably certain to expose juvenile salmonids and redds to increased levels of turbidity. For projects constructed in isolation from the flowing water, the increase in turbidity would occur after reintroduction of flow into the work area. The combination of fine substrates and larger flows will result in higher levels of turbidity that will extend further downstream than in situations where the substrates are larger and flows are lower. Generally, the increase in turbidity could last for as little as several hours but may last for several days on larger projects. For projects constructed in the wet in coarse substrates the increase in turbidity is expected to be negligible. However, for projects in finer substrates the turbidity is likely to result in negative effects to juveniles. For projects constructed in the wet with short in-stream action, the increase in turbidity is also expected to be short in duration.

Other programmatic consultations for similar restoration projects with in-stream components assume negative downstream impacts from turbidity of 600 feet per project (USFWS 2006b) and 1000 feet (NMFS 2007). For this consultation, the applicant will report the project length and visible downstream turbidity. NMFS assume that on average within 50 percent of the visible plume significant disturbance of respiration and feeding in juveniles will occur. NMFS assume that on average the same downstream effect will occur with the first fall/winter freshets. The resulting stream miles, project length plus 50 percent of visible downstream turbidity, will be added at the project sites.

General Effects of the Proposed Restoration Activity Categories

1. Fish Passage Restoration. Installing or modifying fish passage structures will address stream blockages from culverts, tide gates, sediment bars and small diversion dams. This project category is not intended to include large scale, mainstem, hydroelectric or flood control dams or other large scale projects, or to provide passage beyond natural barriers. Restoring passage will provide access to historic salmonid spawning and rearing habitat. Long-term habitat improvements also include better bedload and debris movement. Thus, improving fish passage is expected to result in long-term benefits to abundance, productivity and special diversity of salmonids.

The loss of accessible habitat resulting from structures that block fish passage is one factor responsible for the low abundance and productivity of Washington's salmon and bull trout populations. Removing fish passage barriers is identified as a primary recovery tool in all of the salmonid recovery plans. Thus, NMFS expect significant, long-term habitat benefits to result from this project category. We expect the long-term benefits of restoring fish passage to far outweigh the short-term construction related negative impacts that will result from this project category.

The construction process for replacing culverts and removing tide gates involves significant in-stream work. It will adversely affect water quality by increasing instream turbidity during construction, and shortly thereafter. With increased turbidity, increased substrate embeddedness and pool filling are possible during and after construction, until equilibrium in and around the new structure has been established. Finally, construction for projects on larger streams and in finer substrate material will in many cases involve worksite isolation to avoid salmonid exposure to the acute effects of instream construction. While worksite isolation is a minimization practice, consisting of several measures meant to decrease fish exposure to the effects of construction activities, it likely will injure or kill some juvenile salmonids.

Worksite isolation practices include methods as simple as stream seining to "herd" fish out of the worksite, dip netting to physically remove fish, and electrofishing to shock, locate and remove those few residual juveniles that might have successfully "hidden" from other removal techniques. These techniques are meant to locate and remove all fish from worksites prior to diverting water around the construction site. None of these techniques is likely to be completely successful. Therefore, some fish are reasonably certain to be stranded during dewatering, in addition to any stress they incur during removal techniques.

2. Installation of Instream Structures. Installing instream structures will increase spawning, rearing and resting habitat for salmonids, provide places of refugia from high instream flow, and increase interstitial spaces for benthic (salmonid food) organisms. These habitats for fish are created, because each piece of wood or engineered log jam that is installed will increase the structural complexity and diversity of instream habitat. In-stream wood creates cover, pools, reduces sediment deposition in spawning gravel, and increases oxygen levels caused by turbulence as water flows over and through the structures. In areas where the width/depth ratio of the stream has been altered by removal of LWD, channelization, and land use change, the addition of in-stream wood restores historic function. Finally, instream structures can restore

historic hydrologic regimes, decrease high flow velocities, and deflect flows into adjoining flood plain areas, restoring connections to juvenile refugia and rearing habitat in wetlands, old channels, and the floodplain at large.

The construction process for adding instream structure will adversely affect water quality by increasing instream turbidity during construction, and shortly thereafter. With increased turbidity, increased substrate embeddedness and pool filling are possible during and after construction, at least until equilibrium in and around the new structure establishes, after which deposition is likely to be flushed away. Finally, construction could involve worksite isolation to avoid salmonid exposure to the acute effects of instream construction. While worksite isolation is a minimization practice, consisting of several measures meant to decrease fish exposure to the effects of construction activities, it likely will injure or kill some juvenile salmonids. Worksite isolation practices are discussed above.

3. Levee Removal and Modification. Removing, lowering, breaching and setting back levees will improve floodplain and estuarine processes. Improvements are expected to increase the quality and abundance of rearing and winter habitat for salmonids, mainly juveniles. In estuarine areas in Puget Sound, the mouth of the Columbia River and the Olympic Peninsula, the removal and breaching of levees will result in improved tidal circulation and establishment of marsh/tidal channels that provide important rearing habitat for salmonid smolts.

In freshwater areas, the removal, lowering and setting back of dikes will result in improved floodplain processes, including increased floodplain connectivity, flood storage and increased availability of floodplain rearing habitat.

As shown above, this project category, in estuarine and freshwater areas, is directly linked to addressing limiting factors and improving salmonid habitat. This gives NMFS high confidence in expecting large, long-term habitat benefits to result from this project category. We expect these benefits to by far outweigh the short-term construction related negative impacts that will result from this project category.

Removing, breaching and lowering dikes and regarding/restoring hydrology in the proposed marsh areas involves the use of heavy equipment in the floodplain. Regrading of topography in the area to be re-opened area usually can be done prior to and in isolation from the water. However, dike work, even if done at low tides, will involve some water contact towards the end of construction. This will adversely affect water quality by increasing turbidity during construction. Increases in turbidity will periodically occur with major flow events and tidal cycles, till marsh vegetation is fully established. For some salt marshes increased turbidity during major flow events may persist for several years.

4. Side Channel/Off-Channel Habitat Restoration and Reconnection. Restoring access to and improving the condition of side channel habitat will increase the availability of rearing habitat and refugia from high instream flow, enhance hydrologic moderation of instream flow, and enhance habitat diversity and complexity. These functions will be accomplished by removing existing blockages to secondary channels (removing built up sediments, for example), adding

structures that enhance connectivity by maintaining a functional flow regime into existing secondary channels, and constructing/revitalizing side channels.

As detailed in the associated CM 1, side channel restoration will be accomplished in isolation from the main channel with establishing a connection to the main channel being the last step. This final step is likely to result in a short-term increase in turbidity in the main-stem.

Installing in-stream structures for grade control at the outlet of the side channel will result in impacts described under "Installation of In-stream structures".

9. Debris and Structure Removal. The removal of debris including bank protection as well as the replacement of bank protection with softer bank stabilization methods will improve riparian habitat conditions including cover and shade. In addition, the installation of some bank protection structures like ELJs, root wad toes and wood groins will also provide increased rearing habitat and cover. The removal of bank protection will be combined with some riparian restoration/re-vegetation.

Thirty-three percent of Puget Sound shorelines have been modified with bulkheads or other armoring. The creation of additional estuarine habitat in the major river deltas and the restoration of shoreline processes which both can be achieved through removal of shoreline armoring is one of seven key actions the recovery plan for Puget Sound proposes, Chapter 6 (Shared Strategy 2007). Another of the seven key actions outlined by the Puget Sound Recovery Plan (Shared Strategy 2007a) is the protection and restoration of freshwater quantity. This goal will be furthered by the debris removal proposed under this action category.

The construction process for removing debris and bank protection will in some cases adversely affect water quality by resulting in a short-term increase in turbidity during construction, and shortly thereafter. As discussed above, in the freshwater environment increased turbidity can result in increased substrate embeddedness and pool filling during and after construction. In the estuarine and marine environment increased turbidity in the near-shore may impact juvenile salmonids. Finally, construction for some projects will involve partial worksite isolation (lateral coffer dams) to avoid salmonid exposure to the acute effects of instream construction. While worksite isolation is a minimization practice, consisting of several measures meant to decrease fish exposure to the effects of construction activities, it likely will injure or kill some juvenile salmonids. Worksite isolation practices are discussed above.

2.4.2 Effects on Salmon and Steelhead Critical Habitat

The NMFS established above that the only significant adverse effects on habitat would be short-term and construction related, mainly water quality effects in the form of increased suspended fine sediment and sediment deposition. The critical habitat analysis begins with a summary of the effects of the proposed restoration activity categories on critical habitat PCEs. An evaluation of how changes in PCEs affect conservation value at the watershed scale and then the species-wide scale follows.

Freshwater Spawning Sites. Hood Canal summer-run chum salmon spawn in the lower portions of natal rivers including the Duckabush River. There is no freshwater spawning for PS Chinook salmon or steelhead in the action area for any of the three PSNERP restoration projects.

Water quantity: The proposed activity categories will not reduce water quantity with the exception of short-term construction actions that require work area isolation. In these cases, water quantity in a very small area, typically a maximum of several thousand square feet may be reduced for a maximum of several days. In the long-term some projects will improve late season stream and hydraulic processes related to tidal flow in, and just upstream of the estuary. Projects that are designed to improve stream-floodplain connection such as levee removal and modification and side channel/off channel habitat restoration will result in greater storage of water in the floodplain. This water will then be available for late season in-stream recharge.

Water quality: Short-term adverse effects to water quality will occur when near or in-water construction occurs. Increased turbidity resulting from construction will last for a few hours to a maximum of a few years (levee setbacks). Minor inputs of chemical herbicides as described earlier will degrade water quality for a period of hours to days.

In the long term, many proposed restoration activities are designed to improve water quality. Planting riparian areas creates shade which will incrementally reduce summer stream temperatures. Fencing off riparian areas from livestock use will reduce chronic streambank erosion and decrease turbidity.

Substrate: Fine sediments mobilized by construction activities will settle out in downstream substrates resulting in a minor, short-term increase in substrate embededdness. Over the long term, many restoration activity categories like riparian plantings are designed to reduce inputs of fine sediment.

Freshwater Rearing Sites. Water quantity will be affected as described above. NMFS do not expect construction related adverse effects to floodplain connectivity. Long-term beneficial effects are the intent of several activity categories including levee removal and modification and side channel/off-channel habitat restoration and are the heart of each of the three PSNERP projects. These actions will restore or improve the interaction between the stream and its floodplain. They are likely to result in improved floodplain storage and incremental elevation of the water table. Water quality will be affected as described above. Minor reductions in invertebrate forage will occur as a result of short-term, small scale construction related increase in fine sediment or worksite isolation. NMFS expect that the affected construction area will be recolonized by invertebrates within a few months. Invertebrates will quickly move into restored stream areas by drift from upstream and by eggs from adults. Short-term reductions in algae and macroinvertebrates will occur as described in the analysis of herbicide effects. In the long term, all of the restoration activity categories that improve riparian function reduce inputs of fine sediments, and help to encourage establishment of healthy riparian plant community, will resulting in increased terrestrial and aquatic forage. Riparian disturbance caused by construction activities for access and site preparation will result in some minor reduction of overhead cover at project sites. In the long term, many restoration activity categories such as large wood and

boulder placement, riparian fencing, and riparian planting will improve cover for salmonids and steelhead.

Freshwater Migration Corridors. Fish passage: Construction activities may temporarily impede fish passage for a maximum of a few days. In the long-term the proposed culvert replacement, tide gate removal, and removal of irrigation diversions will all improve fish passage. Water quantity will be affected as described above. Water quality will be affected as described above. Natural cover will be affected as described above.

Estuarine Areas. Construction activities in estuarine areas may temporarily impede fish passage for a maximum of a few days. In the long-term several proposed activities like the removal of tide gates, the replacement of culverts and levee removal or modification will improve fish passage, allowing access to previously blocked estuary and areas. The proposed estuary restoration projects will improve water quality, primarily by reconnecting the estuary to tidal waters. The proposed estuary restoration actions will not affect water quantity, other than by reestablishing tidal influence. The proposed removal of tidegates and levees will reestablish tidal influence and allow periodic inundations of saltwater. This will restore natural salinity levels to historic estuarine areas. The restoration of tidal influence and natural plant communities will provide more cover for salmonids and steelhead. Juvenile salmon and steelhead feed primarily on small to mid-sized invertebrates while in estuaries (Groot and Margolis 1991). Estuary restoration projects that restore natural vegetation and tidal influence will increase the amount of forage available for juvenile salmonids. Adult salmon and steelhead feed on small fish and invertebrates in estuary areas (Groot and Margolis 1991). Reestablishment of natural vegetation, tidal influence, and estuary function improves habitat for salmonids, steelhead, and their forage species. The proposed estuary restoration will increase the amount of forage available for adult salmonids and steelhead.

Relevance of Effects on Primary Constituent Elements to the Conservation Value of Critical Habitat.

NMFS used the watershed or subbasin (fifth field HUC) to evaluate effects to critical habitat. Organizing information at this scale is especially relevant to salmonids, since their innate homing ability allows them to return to their natal watersheds. Across Washington, there are several hundred watersheds with designated critical habitat for one or more listed salmonid. Most of the watersheds with critical habitat outside of Federal lands were rated as having medium conservation value.

As summarized above, the proposed restoration actions will all have long-term beneficial effects on critical habitat PCEs at the watershed scale (see also, section 2.4.3, below). The construction related adverse effects to PCEs are expected to be minor and persist for a short time (typically a few weeks). At each project site where the COE carries out restoration actions, the incremental improvements to the condition of PCEs will improve the ability of these watersheds' habitat to contribute to the conservation of listed salmonids and steelhead.

At the species-wide scale, NMFS expect that the incremental improvements to watershed condition resulting from the proposed actions will collectively enhance the habitat and VSP

parameters of the listed salmonids and steelhead. All of the proposed actions are supported by either recovery plans or other major watershed analysis and thus we expect them to further recovery.

2.4.3 Effects of Planned Restoration for the Three PSNERP Actions

The following section divides the effects analysis into three separate sections. Each section focuses on one of the proposed restoration actions. The first element of each section describes the effects of each action in terms of the proposed restoration actions and their intended outcomes for processes that make and maintain habitat for listed species in each action area. Thereafter, each section briefly describes the relevance of these actions to listed species and to designated critical habitat in each action area. Because the COE submitted each action requesting consultation at the conceptual (10 percent design) stage of development, neither NMFS nor the COE possess information from which to derive a more specific analysis. By integrating the prescriptive aspects of NMFS No. NWR-2008-3593, the COE would ensure that the construction effects of each action would be minimized to the maximum practicable extent.

Duckabush River Delta Restoration

Highway 101 cuts across the intertidal river delta and estuary wetland complex. Where it crosses the wetland and small distributary channels, the highway is presently elevated on fill, with only two small culverts, thus severely affecting water flow, sediment transport, and morphology. To improve estuary processes, the COE proposes to replace existing structures with elevated structures, reconnect distributary channels, place large woody debris structures, remove fill (training berms, embankments, developed areas), and revegetate areas.

Reconnection of the north distributary channel would improve estuary processes by restoring delivery of fresh water and fluvial sediment. Removal/bridging of existing surface streets (Duckabush River Road, Shorewood Road) would reconnect freshwater and tidal flows to remnant distributary, tidally influenced channels, and tributary wetlands.

Removal of training berms along the active river channel would reconnect the river to its intertidal floodplain and wetlands, restoring floodplain and estuary wetland processes and increasing channel density. Removing these multiple stressors would restore dynamics and promote greater diversity and acreage of delta wetland habitats.

Installation of caissons or cofferdams will be required where bridge piers would be located in water prior to drilling shafts to isolate the work zone. These devices will be installed and removed during the in-water work window. Removal of piles from existing bridges will require measures to contain sediment. The most appropriate methods will be selected during the pre-construction engineering and design phase (PED). Due to the disruptive nature of pile removal and installation and the potential need for temporary fill for access, it is best to isolate the work to minimize stress and harm of salmonids. Other in-water work associated with dike breaches and rehabilitation of channels will be sequenced and timed during the summer work window to minimize exposure to salmonids, and industry standard best management practices would be used.

The need for isolation of training berm, road embankment, and road removal work and specific measures of the in-water work plan will be determined during PED. Drilling and casting the pier in place for pier installation and vibratory pile driving for ground testing and pile removal are expected to be the best methods (COE 2015). If other methods are determined to be necessary during the PED phase, then the COE will discuss with the Services whether reinitiating consultation is necessary. No blasting is anticipated, as the foundation soils are composed of soft materials. The need for and number of temporary crossings will be determined during PED phase. Because conceptual design does not afford NMFS the detail needed to analyze the effects of these elements, we assumed the complete application of the appropriate measures in Appendix A of NMFS No. NWR-2008-3598, as needed. Departure from those measures would be a basis for the COE and NMFS to consider the need to reinitiate consultations (per Section 2.10 of this opinion).

Finally, temporary crossings may be needed at the new bridge construction, culvert removal, new roadway approach sections, and two bridge removals. Most channel excavation, embankment removal, and fill removal will be accomplished with land-based heavy construction equipment. Large-diameter casing shoring may be required to keep water out and allow access to the top of the drilled bridge pier shafts. A crane will be required to set the girders in place. The temporary trestle or earth fill can then be removed. The project is expected to take two to three years to construct. Table 5 summarizes the extent of removal of stressors to hydraulic function under this proposed action.

Table 5. Stressors Removed under Full Restoration

Stressor	Full Restoration
Tidal Barrier (LF)	1,950
Fill (area) Channels	5.7 acres
Fill (area) Training Berms	0.7 acre
Fill (area) Development	2.5 acres
Nearshore Roads (LF)	Same as tidal barrier

Removing the major tidal barrier created by the presence of Highway 101 on bedload fill across the Duckabush Estuary will require activities commonly seen in transportation actions on which NMFS consults. These include, but are not limited to road removal; bridge and culvert removal; excavation to remove fill, levees and berms; and excavation to create connections to relict and other distributaries in and around the old road location. These also include building the new elevated roadway and drilling and pouring of caissons for piers on which the new elevate road will lie.

Each of these activities can cause environmental effects to which listed fish present in the action area would be exposed. The most prominent of these effects is increased turbidity in waterways receiving any overland transport of sediment disturbed by any of the activities identified above. The extent of these effects would be constrained by the application of the measures in Appendix A as was analyzed in NMFS No. NWR-2008-3593.

The effects of increased suspended solids (SS) on salmonids depend on the extent, duration, timing, and frequency of increased SS at the place where it will occur (Bash et al. 2001). Depending on the level of these parameters, sedimentation can cause lethal, sublethal, and behavioral effects in juvenile and adult salmonids (Newcombe and Jensen 1996). Behavioral effects in response to elevated SS levels include avoidance, sub-lethal effects include reduction in feeding rates, stress, gill flaring, and coughing (Spence et al. 1996).

NMFS expect adults and sub-adults to leave areas with elevated levels of turbidity that would result in significant impairment of respiration and feeding. Thus, they would be mostly affected by the effects of temporary displacement, rather than the direct effects of exposure to increased turbidity. Juveniles on the other hand are more likely to seek cover, rather than leave, and, because they are less mobile, are more likely to be exposed to construction-related turbidity. The summer in-water work windows are designed to reduce impacts on redds and limit exposure to juvenile salmonids, thus reducing the likelihood for adverse effects to the most vulnerable life history stages from increased sedimentation. However, sedimentation from natural causes, such as rainstorms and slope failure, is mostly correlated with high flow events that occur during winter.

North Fork Skagit River Delta

The proposed NF Skagit River restoration action is less environmentally demanding than the Duckabush River Estuary project in that the NF Skagit project does not require wholesale removal and replacement of a major transportation causeway. Conceptual plans combine multiple elements intended to restore the natural hydrologic, sediment, and ecological processes to a substantial portion of the North Fork Skagit River delta. These activities consist mostly of topographical changes through excavation of ground that would become exposed to the river and estuary after completing levee and berm removal, breeching, or setting-back.

The proposed restoration activities include lowering and breaching levees; constructing new levee to maintain existing level of flood risk management; excavating tidal channel network; removing shore armor, buildings, pavement, boat ramp, and roads; and vegetation planting. The need for and number of temporary crossings will be determined during the PED phase. Unlike the Duckabush restoration action, the proposed action involves no large scale roadway removal or replacement. Therefore, temporary crossings will not be necessary. Most tidal channel excavation, levee modification and construction, debris and structure removal, and planting will be accomplished with land-based heavy construction equipment. In-water work associated with levee breaches will be sequenced and timed during the summer work window to minimize exposing salmonids to turbidity or other disturbance, and industry standard best management practices would be used. Some limited earthwork with water-based equipment (i.e., from a barge) may be needed for shore armor removal, but this will be verified during PED. Need for isolation during in-water work and specific measures of the in-water work plan will be determined during PED. The project is expected to take one to two years to construct.

Table 6 summarizes the extent of removal of stressors to hydraulic function under this proposed action.

Table 6. Stressors Removed under Full Restoration

Stressor	Full Restoration
Tidal Barrier (LF)	Lower existing dike (16,140 LF)
Armor (LF)	Remove 16,140 LF of armor on dike along North Fork
Marinas (area)	Remove Blake's Resort ~ 7.5 acres

Nooksack River Delta Restoration

Like the proposed NF Skagit River Delta Restoration action, the Nooksack River Delta Restoration involves less demanding construction activities on the ground to complete. However, the project covers a larger area and a greater number of activities to complete.

The proposed Nooksack River restoration combines multiple elements intended to restore the natural hydrologic, sediment, and ecological processes to a substantial portion of the Nooksack delta. The proposed restoration activities include levee removals, breaches, and setbacks; channel creation and rehabilitation; hydraulic modifications (engineered diversion at the Lummi River connection to the Nooksack River); substantial property acquisition; alterations to bridges and other transportation elements; and vegetation planting.

The need for and number of temporary crossings will be determined during the PED phase. Temporary crossings may be needed at all six bridge replacements and the regrading and installation of a diversion device at the Lummi River.

Most channel excavation, embankment removal, and fill removal will be accomplished with land-based heavy construction equipment. All activities will comply with the appropriate measures identified in Section 1.3 of the opinion. Temporary trestle structures and/or local filling may be required along portions of the proposed bridge alignments to provide access for heavy equipment during construction. Large-diameter casing shoring may be required to keep out water and allow access to the top of the drilled bridge pier shafts. A crane will be required to set the girders in place. The temporary trestle or earth fill can then be removed. Drilling and cast in place for pier installation and vibratory pile driving for pile removal and ground testing are expected to be the best methods.

If other methods are determined to be necessary during the PED phase, then the COE will discuss whether reinitiating consultation is necessary. No blasting is anticipated, as the foundation soils are composed of soft materials. Construction duration for each of the six bridge replacements ranges from 10 to 18 months. The project is expected to take two to four years to construct.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Because these activities will occur in and around waters of the U.S. regulated by the COE, we expect no direct in-water cumulative effects as defined by the ESA that are expected to occur within any of the three action areas for the three PSNERP proposed actions. Federally controlled actions (COE permit actions in the aquatic action area) dominate current and future impacts in the action area and Federal actions would require section 7(a)(2) consultation under the ESA. NMFS is not aware of any specific future non-Federal activities within the action area.

Future actions will be regulated by state and local government. These regulations are intended to restrict, but do not eliminate, increased input of pollutants and other degrading factors to low levels, although chronic low level inputs are still likely, including input of unregulated compounds such as pharmaceuticals and cosmetic elements, the effects of which are not well documented. The regulatory restrictions on water quality degradation will become increasingly important for the conservation of ESA listed species as human population increases and contaminant input levels rise over time. Regardless of the efficacy of regulatory restrictions in place, even with regulatory oversight of chronic low-level inputs of both regulated and unregulated contaminants will continue to impair water quality into the future and reduce the likelihood of successful growth to maturity for ESA listed species in the Puget Sound.

Although state, tribal and local governments have developed plans and initiatives to benefit ESA listed salmon and steelhead, NMFS cannot consider them reasonably certain to occur in its analysis of cumulative effects until more concrete steps are taken in their implementation. Government actions are subject to political, legislative and fiscal uncertainties. These complexities make analysis of cumulative effects difficult. To the extent that recovery plan actions are implemented and regulatory mechanisms are applied to on-going actions, adverse cumulative effects may be minimized, but will not be completely avoided.

There are some impacts that we predict are reasonably certain to occur into the future, such as limited upland construction, in-water traffic and commercial activities, and other habitat altering activities. As these actions all occur within the floodplain of each river system, those actions would occur under the overlay created by implementation of the FEMA National Flood Insurance Program in Western Washington, which itself has been the subject of ESA section 7 interagency consultation (NMFS No. NWR-2006-472). Therefore, although the main factor driving cumulative effects on listed salmonids in Puget Sound is population growth and associated development, that development is moderated by the results of that consultation. Accordingly, NMFS assumes that future private and state actions will continue within each action area, but at a diminished pace and with additional requirements to protect and conserve habitat quantity and quality in each action area.

The NMFS expects climate change to increasingly affect certain habitat variables such as temperature and stream volumes. Habitat conditions will also be impacted by increased flood risk as more precipitation falls as rain instead of snow, causing increased frequency and volumes of flood events that will scour eggs in the gravel and diminish available habitat for salmon (Beechie et al. 2006). These effects would be more pronounced in the upper watershed where spawning occurs, and ocean-type fish like PS Chinook salmon are less likely to be exposed to these effects because they typically out-migrate from their natal stream and rivers well before the onset of summer when water temperatures begin to increase (Battin et al. 2007). At the other end of the life cycle, adult prespawn survival and fertility may decline due to higher temperatures (Crozier et al. 2008). However, while the studies cited above project negative impacts from climate change there is still some uncertainty regarding how climate change will affect salmonids in the action area.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species.

The COE proposes to carry out three discrete restoration projects within the river estuaries of three rivers in Puget Sound: the Duckabush River Estuary in Jefferson County, the North Fork Skagit River Estuary in Skagit County, and Nooksack/Lummi River estuary in Whatcom County. The projects include a variety of road removal, road replacement and elevation above bedload, culvert removal and replacement with bridges, berm and levee removal and setbacks, and reconstruction of connections between extant waters of the U.S. and former distributaries and other forms of off-channel habitat.

Conditions in the environmental baseline (Section 2.3) at each of the three action areas are consistent with each other. In each action area, estuary wetland function is presently constrained by lack of hydraulic exchange and lack of connectivity to existing and former off-channel distributary habitat. The proposed actions would eliminate those baseline constraints and enable processes to occur that would continue to improve habitat conditions in each place into the foreseeable future.

To conduct these actions, contractors will have to engage in a number of excavation and other soil moving or disturbing activities, near or in waters of the U.S. that could experience occasional increases in turbidity for short distances up and downstream of the source of soil to the water. In addition, the COE would be using techniques to reduce fish exposure to construction activities such as worksite isolation, which although reducing overall exposure are reasonably certain to injure or kill a limited number individual listed fish unless they can be

executed during the prescribed windows during which few, if any vulnerable individuals would be exposed to those activities.

The desired outcome of the planned restoration activities is increased function of the processes that create and maintain estuary wetland habitat (see Section 2.4.3). The benefits over time of increased functionality would be increased hydraulic exposure and interchange of estuary waters within each estuary. In addition, these changes would create added fish access to new and former off-channel distributary habitat. This habitat supports juvenile rearing for ocean-type Puget Sound Chinook salmon populations in the Nooksack and Skagit Rivers that spend more time rearing in the estuarine life history of their life cycle than do stream type Chinook populations. Increased function in the estuary would improve the capacity of the affected estuaries to support the rearing life history of affected populations in these systems, increasing their capacity to survive their subsequent, ocean life history.

Similarly, benefits of the Duckabush River Estuary restoration would accrue directly to HC Summer-run chum salmon in the Duckabush River. They rear in their natal estuary and estuary restoration is named as a priority in the Hood Canal Summer-run Chum recovery plan (HCCC 2005). The amount of potential increase in population abundance is greatest through restoration of freshwater reaches and connectivity with natal sub-estuary; full restoration of estuarine-marine waters and the natal sub-estuary appear to offer similar levels of benefit (HCCC 2005). Increases in abundance of this population would obviously help ensure against the adverse effects of other factors bearing on the conservation prospects of the ESU; prominently, poor ocean conditions (HCCC 2005).

In contrast, PS steelhead move quickly through the estuary as they emigrate to Puget Sound. Therefore, they will experience less of the benefit of increased estuary function. But the long term benefits of these actions clearly outweigh the short term detriments imposed by short bursts of increased turbidity and implementation of worksite isolation measures (PSNERP 2012). In fact, take of individual fish of during the one- to four-year construction periods for these three project would be dramatically outweighed by the increased estuarine function for each project. That increased function would enable increased productivity in all three systems which would lead to increased abundance, all other factors being equal (PSNERP 2012, HCCC 2005, NMFS 2007). Increased productivity, leading to increased abundance of individual fish comprising the populations of the ESUs of salmon and the DPSs of steelhead that spawn and rear in these three systems, will improve the conservation prospects of those ESUs and DPSs, beginning as soon as these systems' estuarine processes are restored.

The estuarine PCEs of critical habitat (Section 2.3.2) include areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. Section 2.4.3 provides a description of how the proposed restoration activities would improve estuarine hydraulic interaction in ways that would improve conditions for rearing and transition to saltwater life history, before affected salmonids head to Puget Sound or the Pacific for their ocean life history. Improving the capacity of these places to

better support a larger number of individual fish from the affected populations would improve the conservation prospects of those fish the ESUs and DPS. As such, this would be evidence of increasing the conservation value of these three estuaries and improving their conservation role (Hogarth 2005).

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Hood Canal Summer-run chum salmon, Puget Sound Chinook salmon, and Puget Sound steelhead. Furthermore, the proposed action will not destroy or adversely modify its designated critical habitat for Hood Canal Summer-run chum salmon, Puget Sound Chinook salmon, or Puget Sound steelhead.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take would occur as follows:

The proposed action will modify habitat to an extent that causes harm of some exposed fish, as defined above. Therefore, the proposed action is reasonably certain to cause take of listed fish. The habitat modification causing take will do so by impairing normal rearing behavior. The source of harm assessed in this consultation is temporary turbid conditions in all three action areas. Other sources of take include capture and handling of fish from isolated work areas in all three action areas.

The NMFS' ability to quantify the amount of take in numbers of fish depends on whether NMFS has sufficient information to determine the number of fish that will be exposed, the manner in which each exposed fish will respond to exposure, and whether those responses will fall into one of the categories of take, listed above. For take in the form of harm, this assessment can be

difficult if not impossible to accomplish because of the range of individual fish responses to habitat change. Some fish will encounter changed habitat and merely react by seeking out a different place in which to express their present life history. Others might change their behavior, causing them to express more energy, suffer stress, or otherwise respond in ways that impair their present or subsequent life histories. Yet others will experience changed habitat in a way that kills them.

For the short term effects of the action, NMFS cannot predict the number of fish that would be exposed to the effects of construction. Estimates of the effects of the predicted bursts of turbid water and the worksite isolation and fish handling measures are impossible at the conceptual design phase as the precise number of fish affected by conditions resulting exclusively from the proposed maintenance of the levee cannot be determined. We can appreciate incremental changes from temporary decreases in water quality in each action area, but cannot ascertain an exact amount or location where the changes occur and to what degree it affects individual adult or juvenile salmonids.

While this uncertainty makes it impossible to quantify take in the form of harm in terms of numbers of animals injured or killed, the extent of habitat change to which present and future generations of fish will be exposed is readily discernable and presents a reliable measure of the extent of take that can be monitored and tracked. Therefore, when the specific number of individuals "harmed" cannot be predicted, NMFS quantifies the extent of take based on the extent of habitat modified (51 FR 19926 at 19954; June 3, 1986).

The extent of take from the exposure of individual PS Chinook salmon, HC summer-run chum salmon, and PS steelhead to the short term effects of the action (capture and handling, and turbidity) NMFS assessed the likely extent of habitat affected by these factors for each instance, without knowing the total number or location of those instances. However, knowing the likely outcome of each activity regardless of when or where those instances arise is the basis for programmatic assessment of take in programmatic consultation such as that in NMFS No. NWR-2008-3598 which frames the scope of these three batched consultations.

For take in the form of turbidity, water quality changes will be short in duration and result from a visible plume no larger than 300 feet downstream from the construction site. This distance of turbidity plume represents the absolute largest extent of modified habitat causing harm of listed fish that would occur under the exemption provided in this statement.

For take in the form of worksite isolation, we expect that no more than 1,000 juvenile salmonids (PS steelhead, HC chum salmon. and PS Chinook salmon) will be captured at each project site. Based on previous experience with work area isolation carried out with the proposed protective measures, we expect no more than 5% of these fish will be injured or killed.

2.8.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). "Terms and conditions" implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

Reasonable and prudent measures are nondiscretionary measures to avoid or minimize take that must be carried out by cooperators for the exemption in Section 7(o)(2) to apply. The COE has the continuing duty to regulate the activities covered in this incidental take statement where discretionary Federal involvement or control over the action has been retained or is authorized by law.

The NMFS believes that full application of conservation measures included as part of the proposed action, together with use of the reasonable and prudent measures and terms and conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of listed species due to completion of the proposed action.

The COE shall:

1) Minimize incidental take from construction activities (fish capture and handling, and increased turbidity).

2) Prepare and provide NMFS with plan(s) and report(s) describing how listed species in the action area would be protected and/or monitored and to document the effects of the action on listed species in the action areas.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the COE or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The COE or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

   a. The COE shall implement each minimization element of NMFS No. NWR-2008-3598 by incorporation into project design as the COE proceeds from the concept to 30, 60, and 90 percent design phase as described in section 1.4 of this opinion.

      1) for all three PSNERP actions, the COE shall submit to NMFS additional information on the design and construction plan for each action as the COE proceeds through the design process and prior to initiating construction.

      2) information the COE provides under 1(a)(1) must include an express description of measures the COE determinations it cannot implement along with a rationale for not incorporating the measure into the restoration design. All such information must be sufficient to provide the agencies a basis to determine whether they need to reinitiate consultation under section 2.10 of the opinion.

2. The following terms and conditions implement reasonable and prudent measure 2:

   Track and monitor the project to ensure that the conservation/minimization measures are meeting the objective of avoiding and minimizing take, including turbidity monitoring during construction. The COE shall monitor turbidity levels and erosion control activities, including minimization measures and BMPs, to ensure that the project complies with Washington State water quality standards (this consultation does not exempt take associated with exceeding water quality standards). The COE shall report the results of the turbidity monitoring and the effectiveness of the erosion control BMPs and other minimization measures, to NMFS within 60 days of project completion, including the following information at a minimum:

   a) Starting and ending dates of construction including starting and ending dates of in-water work;
   b) Total length of repair;
   c) As-built drawings if any construction elements were not installed per plan;
   d) Results of turbidity monitoring and BMP effectiveness.
   e) Number of fish captured, injured, or killed during work area isolation.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS makes no additional conservation recommendations in these consultations.

2.10 Reinitiation of Consultation

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

The NMFS considered whether the proposed actions are likely to adversely affect SRKW in the context of effects of the proposed actions will have on PS Chinook salmon, a primary food item of the SRKW. The proposed restoration actions will cause adverse effects in the habitat of PS Chinook salmon that NMFS has determined could injure or kill individual PS Chinook salmon. However, the number of individual fish that could be injured or killed by the proposed actions is so small that NMFS does not anticipate the proposed action would decrease the extent of available food for SRKW in any measureable or meaningful way. To be sure, any decrease in the amount of fish available attributable to the effects of the proposed actions would be far too small a number to actually injure a single SRKW for lack of food. Therefore the effects of the action on SRKW would be insignificant in the short term before the restoration actions are completed. Stated another way, the action will not cause take of SRKW.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the consultation information provided by the **COE** and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action will adversely affect EFH for Pacific Coast salmon.

3.2 Adverse Effects on Essential Fish Habitat

The relevant effects of each of the three PSNERP restoration actions include temporary and spatially constrained increases in turbid water as described in Sections 2.4.1 and 2.4.2. Other effects that bear only on fish and not fish habitat (i.e. fish handling for worksite isolation) are not included here.

3.3 Essential Fish Habitat Conservation Recommendations

The measures required in the ESA consultation to minimize the effects of construction on water quality would have a similarly conservative effect on EFH. Therefore, NMFS recommends the COE implement Term and Condition 1(a)(1), above, in its entirety. Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, approximately 20 acres of designated EFH for Pacific coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, COE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The COE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the COE and others with an interest salmonid conservation in and around Puget Sound. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this document contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA consultation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, Washington 98115

Refer to NMFS No:
WCR-2015-3719

April 11, 2016

Evan Lewis
Chief, Environmental and Cultural Resources Branch
Seattle District, Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Puget Sound Nearshore Restoration Project (PSNERP), consisting of three Civil Works ecosystem restoration actions in the Duckabush, Nooksack/Lummi, and North Fork Skagit River Estuaries (Jefferson, Skagit, and Whatcom Counties, Washington)

Dear Mr. Lewis:

Thank you for contacting our North Puget Sound Branch Chief regarding our recently completed consultation on the action identified above. We appreciate your candor regarding the Army Corps of Engineers (COE), Seattle District's requirements for securing funding for the underlying projects. With this letter, NMFS clarifies elements of our cover letter and biological opinion to fully assure the COE that the completed consultation provides full compliance with Section 7 of the Endangered Species Act for the three sites recommended for Corps approval, authorization, and construction under the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP).

On November 13, 2015, the COE sent NMFS three individual actions (which taken together represent the recommended plan for PSNERP) to be processed under the NMFS's 2008 Programmatic Consultation with the COE on Fish Passage and Restoration actions in Puget Sound (NMFS Nos. NWR-2008-3598, expired in 2013, and WCR-2014-10665, expired in 2014). The COE's expectation was that the pending consultation on habitat restoration actions intended to replace the 2008 Programmatic Consultations would be (1) similar in process requirements to the 2008 processes, and (2) conclude on a schedule that would accommodate the project timeline of the Corps proposed action. This consultation on habitat restoration actions was initiated by a letter from the COE to NMFS on December 10, 2014).

As devised in early 2015, the proposed consultation strategy was to conclude the new programmatic consultation on various applicable habitat restoration actions, and thereby analyze the PSNERP proposed actions under the new framework. That strategy was

expected to result in a streamlined Section 7 consultation process for PSNERP. The new programmatic consultation is still in process as of the date of our PSNERP Biological Opinion. To meet Section 7 consultation requirements and since the COE submitted information covering these three actions in the format dictated in NMFS No. NWR-2008-3598, NMSF coordinated with the COE to determine the most efficient method for conducting ESA section 7 interagency consultation on the three actions. As a result of those discussions, NMFS and the COE determined to batch all three actions into a single biological opinion for PSNERP. This biological opinion is to include project-specific consultations on the actions and incorporate all relevant information from the expired restoration programmatic opinion. NMFS relied on available design information, measures present in the PSNERP program, and the prescriptive and some analytical elements in NMFS No. NWR-2008-3598, for the consultation, which commenced on January 22, 2016.

On February 11, 2016, formal consultation was completed for these thee PSNERP actions (NMFS Biological Opinion No. WCR-2015-3719). In the final opinion, NMFS considered each of the three PSNERP actions on their merits via batching those considerations for efficiency and to streamline reviews.

In the incidental take statement (ITS), the terms and conditions are described to implement the reasonable and prudent measures. The ITS is structured to ensure the record is completed over time, accounting mainly for the lack of important construction details available during the feasibility phase of the project. According to information available on the PSNERP, the program is structured such that after completing the planning phase, further detail regarding project plans will be captured in subsequent phases at 30, 60, and 90 percent design. That information will be essential in showing that the COE has integrated the specific prescriptive elements described in section 1.3 of the biological opinion (the COE's Proposed Action). The most efficient method for doing so is for the COE to submit to NMFS additional information on the design and construction plan for each action as the COE proceeds through the design process and prior to initiating construction. That information will enable the COE to work collaboratively with NMFS to discern whether or not the provisions of section 2.10 (Reinitiation), which are described by statute, have been triggered. Note that this type of interagency collaboration is typical on projects during the design phase and provides the opportunity to catch issues early that could otherwise trigger reinitiation if not identified until later. The main emphasis is to communicate on the project to move through design and into construction in an efficient manner that is consistent with the scope of the completed Section 7 consultation. Note that, absent one of the standard triggers to reinitiate consultation, the collaboration outlined in the ITS does not provide NMFS with an opportunity to add new RPMs, Terms and Conditions, or other additional requirements to the project.

As for the second Term and Condition in Section 2.8.4 of the BiOp), it contained one inadvertent clause that is not relevant to PSNERP, and we therefore incorporate the following in place of that subsection of the ITS:

a) Starting and ending dates of construction including starting and ending dates of in-water work;
b) As-built drawings if any construction elements were not installed per plan;

c) Results of turbidity monitoring and BMP effectiveness.
d) Number of fish captured, injured, or killed during work area isolation.

The National Marine Fisheries Service, Oregon-Washington Coast Area Office appreciates this opportunity to clarify our agencies' understanding of the opinion and to ensure the adjustments mentioned herein are part of our record. Thanks for your open and collaborative approach to addressing them. If you have further questions or comments, please do not hesitate to contact David Hirsh, North Puget Sound Branch, at 206-526-4506 or david.hirsh@noaa.gov.

Sincerely,

Elizabeth Babcock for

William W. Stelle, Jr.
Regional Administrator

PUGET SOUND NEARSHORE
ECOSYSTEM RESTORATION

APPENDIX K

PUGET SOUND NEARSHORE
Sites Proposed for Additional
General Investigation Studies

Integrated Feasibility Report and
Environmental Impact Statement

US Army Corps
of Engineers
Seattle District

Puget Sound Nearshore Ecosystem Restoration Nine Sites Proposed for Additional Study

Summary

The recommendations contained in the Feasibility Report and Environmental Impact Statement reflect a proposal for construction authorization at three sites across Puget Sound (Duckabush River Estuary, Nooksack River Delta, and North Fork Skagit River Delta). While the recommended plan includes restoration at these three sites, the National Ecosystem Restoration (NER) Plan is a 36-site master plan intended to restore a more diversified scope or projects to be implemented under various restoration authorities and partners. This 36-site plan reasonably maximizes ecosystem restoration benefits and restores over 8,000 acres across all seven Puget Sound sub-basins. The NER Plan includes 16 river delta sites, 10 coastal inlet sites, 6 barrier embayment sites, and 4 beach sites.

Of the 36 sites included in the NER Plan, 12 will be completed without the Corps involvement, 12 will be recommended for authorization under the Continuing Authorities Program or Puget Sound Adjacent Waters Authority, and 9 sites are recommended for additional General Investigation (GI) study. This appendix includes a brief summary of the nine GI projects recommended for additional study. Project summary sheets for each of the nine sites are enclosed as well as estimated total project costs based on best available information.

The nine sites recommended for additional general investigation studies are:

- Big Beef Creek Estuary
- Big Quilcene River
- Chambers Bay
- Dugualla Bay
- Everett Marshland
- Lilliwaup River Estuary
- Tahuya River Estuary
- Snohomish River Estuary
- Telegraph Slough

These nine sites are summarized within this appendix.

Engineering

As part of future feasibility-level design efforts, the Corps will evaluate existing conceptual designs, existing hydraulic, geotechnical, and civil design studies, as well as available survey and geographical information. The Corps will identify additional data needs and analysis to be conducted in the design phase prior to construction. These tasks are anticipated to include site-specific topographic survey and soils testing as well as detailed hydraulic modeling, structural/seismic analysis, and civil design.

Environmental Analysis & Coordination

The Corps will conduct evaluations and public disclosure under NEPA for the additional GI studies. The nine sites are expected to comply with the Programmatic Biological Opinion for Fish Passage and Restoration Projects, with site-specific analysis and response from the Services. National Historic Preservation Act Section 106 compliance will follow a similar path as the Programmatic Agreement that was developed for the first three sites included in the recommended plan for construction authorization. Clean Water Act Section 401 and Coastal Zone Management Act compliance will occur during the design phase prior to construction.

Real Estate

The lands and damages values for the nine sites identified for further study were developed using a combination of Land Cost Estimates and County Assessor's values. Land Cost Estimates were developed for Chambers Bay, Dugualla Bay, Everett Marshland, Telegraph Slough, and Tahuya River Estuary; these Land Cost Estimates were developed by USACE Appraisers in 2012. The land values for Big Beef Creek Estuary, Big Quilcene River, and Lilliwaup River Estuary were developed using 2011 County Assessor's records. Snohomish River Estuary land values were developed using 2016 County Assessor's records.

Cost Estimate

Each cost estimate for the nine sites was prepared at a level commensurate with the early conceptual level of design detail, which should be considered a budget or class IV estimate. A high level District Quality Control review was performed on each cost estimate; however, an Agency Technical Review has not been completed. The cost estimates for the nine sites were developed at different price levels from 2011-2014. In an effort to normalize the estimates, all costs were brought to FY 2016 dollars by updating the labor rates, equipment rates and material pricing. The scope was assumed to remain the same.

Table 1 presents the estimated project cost for each site in FY 2016 dollars as well as the fully funded cost. The project cost consists of the construction cost plus Real Estate, Planning,

Engineering, Design (PED), and Construction Management. The fully funded cost represents the project cost escalated to the mid-point of construction. The study team identified FY2030 as the mid-point of construction for each site.

Preliminary construction schedules for each project were created using durations from the MCACES estimate and logical sequencing of construction features. The study team has not determined the order of construction for the nine sites; thus, all preliminary construction schedules in this appendix have a start date of October 2016. Pre-construction and post-construction activities have not been included in the schedule at this point of design. A more comprehensive project schedule be developed that will identify pre-construction and post-construction activities.

Contingencies were added to the construction costs based on the results of the cost and schedule risk analysis developed for each site. The same contingency was applied to the PED and construction management costs. Real Estate team members developed their own contingencies for Lands and Damages estimates. The cost and schedule risk analyses developed in 2011 to 2014 were updated with the current estimated costs but were not reevaluated. The risk register identifies risks, the cost impact of such risk, and likelihood of occurrence. These projects are at an early conceptual level design so a formal risk analysis was not warranted at this time. Instead, an abbreviated risk analysis was performed that only focused on cost and omitted schedule risks. If any of the nine sites move forward under a GI study, a formal cost and schedule risk analysis will performed to account for construction cost risks, schedule delays, and impact costs.

Table 1: Total Project Cost Summary for Nine Sites Identified for Additional General Investigation Studies

	Project Cost FY 2016 Dollars					Fully Funded FY 2030	
Project Site	**Construction Estimate Total**	**Land and Damages**	**PED & Construction Management**	**Contingency**	**Project Cost Total**	**Escalation**	**Fully Funded Total**
Big Beef Creek Estuary	$ 15,824	$ 200	$ 5,775	58%	$ 34,376	37%	$ 47,082
Big Quilcene River	$ 18,120	$ 1,760	$ 6,613	31%	$ 34,600	36%	$ 47,179
Chambers Bay	$ 130,912	$ 10,577	$ 36,500	66%	$ 295,002	36%	$ 399,886
Dugualla Bay	$ 46,618	$ 6,967	$ 17,014	21%	$ 85,355	36%	$ 116,072
Everett Marshland	$ 183,969	$,600	$ 36,500	29%	$ 293,905	35%	$ 395,655
Lilliwap Creek Estuary	$ 17,556	$ 1,120	$ 6,410	36%	$ 33,994	37%	$ 46,435
Snohomish River Estuary	$ 52,092	$ 23,000	$ 19,014	31%	$ 123,593	35%	$ 166,410
Tahuya River Estuary	$ 15,034	$ 1,115	$ 5,486	26%	$ 27,305	36%	$ 37,262
Telegraph Slough	$ 153,194	$ 15,840	$ 36,500	23%	$ 253124	35%	$ 341,074
Sum Total	**$ 633,319**	**$ 68,179**	**$ 169,812**	**36%**	**$,181,254**	**35%**	**$ 1,597,056**

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PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Big Beef Creek Estuary

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

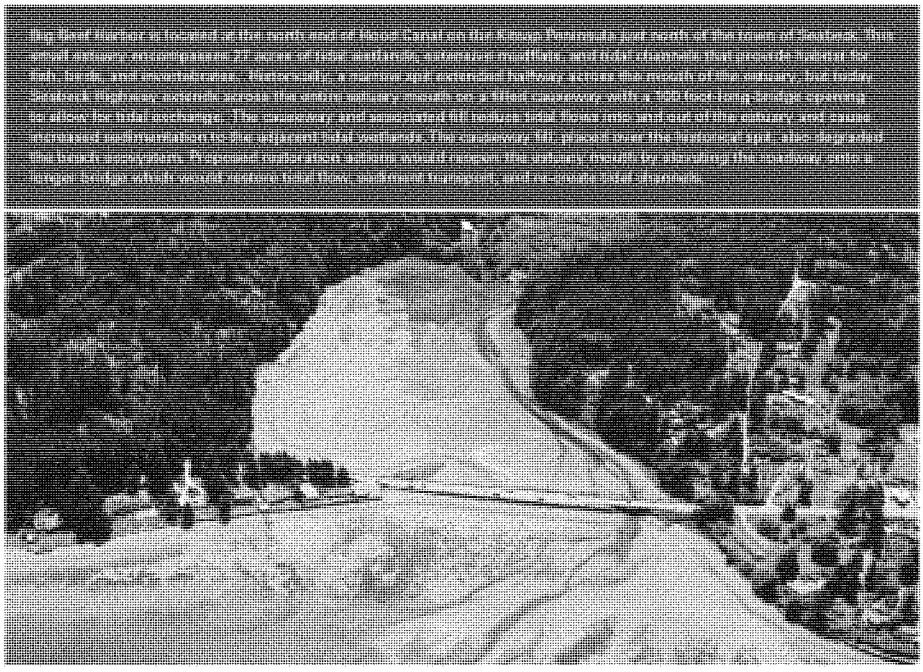


IMAGE: Washington State Department of Ecology (2006)

Processes Restored

- Movement of sand and gravel along shorelines.
- Natural erosion and accretion of beaches.
- Natural formation of tidal channels in estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.
- Unrestricted movement and migration of fish and wildlife.

Conditions Improved

- Restored tidal wetlands, which are highly productive habitats that support biodiversity and provide connectivity between the land and sea.
- Restored coastal embayment that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Restored sand and gravel beaches that serve as spawning grounds for forage fish (e.g., surf smelt and Pacific sand lance), which are a key element of the marine food chain.
- Improved quality of the water flowing through the estuary.

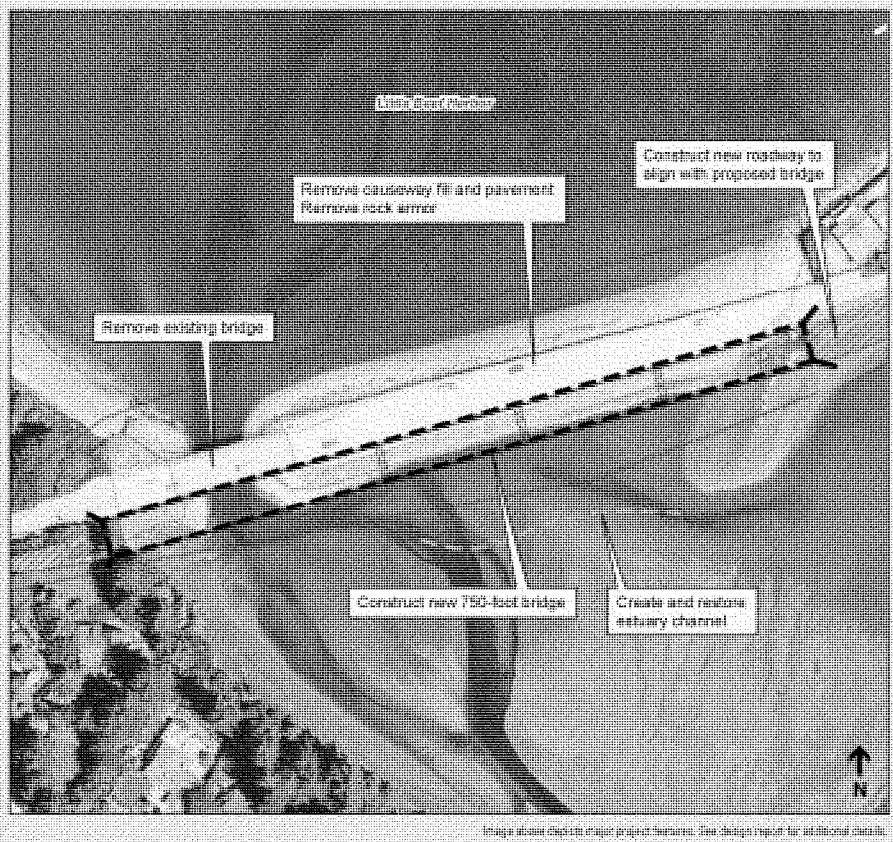


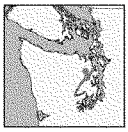
Image shows design major project features. See design report for additional details.

Key Design Elements

The restoration proposed would remove the existing highway to include all roadway fill, armoring, bridge and pavement. A new 750-foot-long bridge would be built to span the entire estuary mouth from the right-of-way on the spit to the low bank at the west shore. The new highway bridge would be constructed immediately south of the current highway, which would allow the road to remain open during construction activities. Restoration would also include restoration of tidal channels within the estuary.

Site Summary Statistics

Area of Restored Process	30 acres
Total Project Cost (Mar 2008 Prices)	$27,570,000
Ecosystem Output Score	7.9



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)

SITES FOR ADDITIONAL STUDY

Big Quilcene River

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

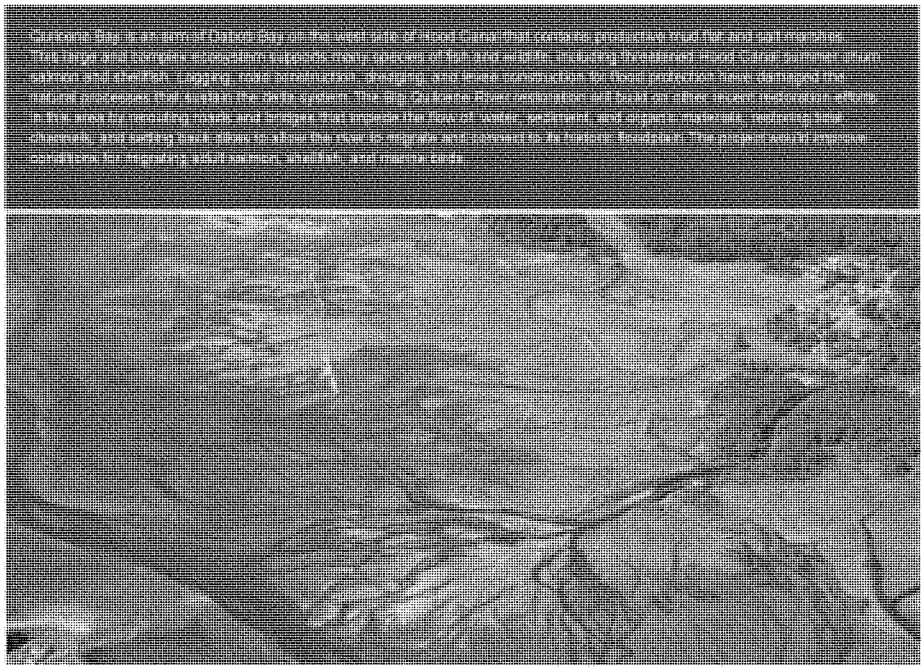


IMAGE: Washington State Department of Ecology (2006)

Processes Restored

- Natural formation of tidal channels in estuaries.
- Unrestricted flow of freshwater rivers and streams into estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.
- Accumulation and retention of organic material from plants and aquatic animals.
- Unrestricted movement and migration of fish and wildlife.

Conditions Improved

- Restored large river delta that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Restored intertidal and shallow subtidal areas that are habitat for recreationally and culturally important shellfish such as oysters, mussels, and clams.
- Re-established intertidal and shallow subtidal areas to encourage the growth of kelp and eelgrass, increasing nearshore productivity for fish, birds and other marine species.
- Improved resiliency of the shoreline to respond to changes in the environment such as sea level change and increasing frequency of storm events.

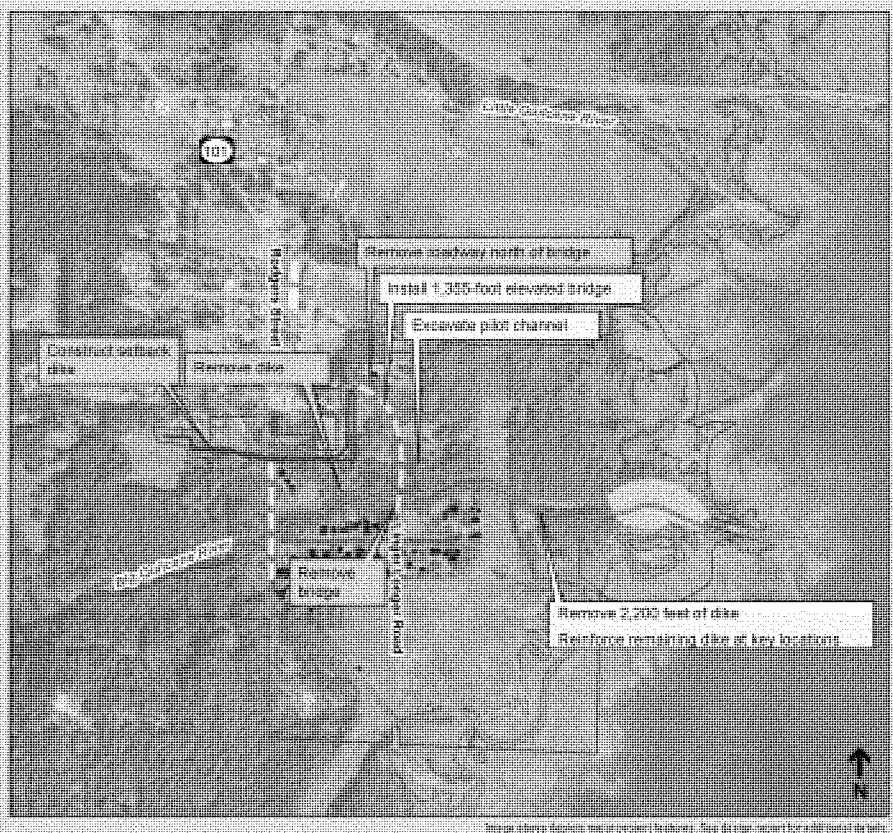


Image shows features under project evaluation. See design report for additional details.

Key Design Elements

The project would restore tidal flow and connectivity to the Big Quilcene River by removing the current blockage associated with Linger Longer Road and construction of an elevated bridge. The channel would be excavated to direct river flows. The dike along on the south side of the river would be partially removed and portions would be reinforced.

Site Summary Statistics

Area of Restored Process:	25-30 acres
Total project Cost (Mar 2008 Prices):	$37,800,000
BD Score:	0.6



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Chambers Bay

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

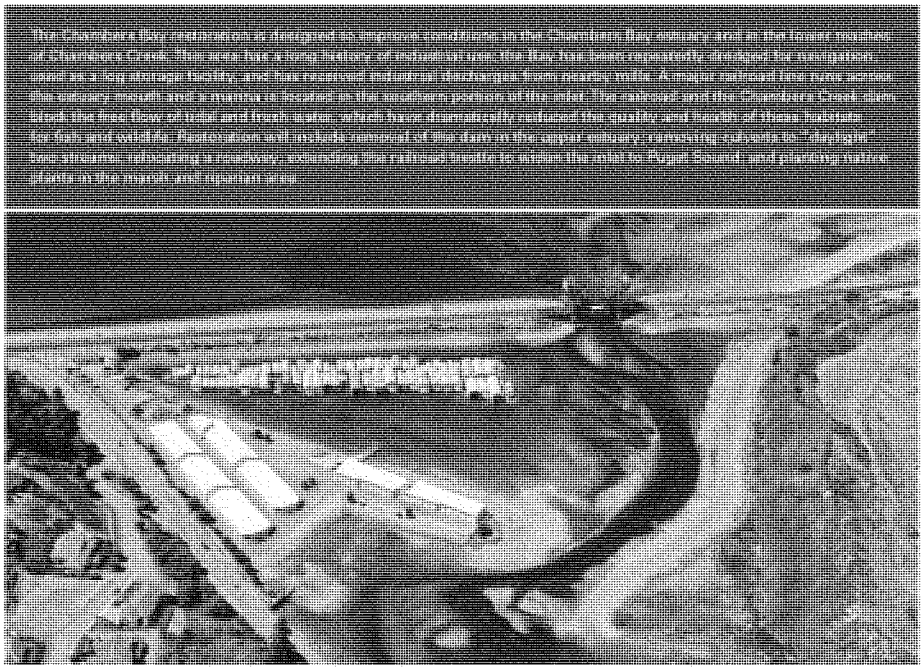


IMAGE: Washington State Department of Ecology (2006)

Processes Restored

- Natural formation of tidal channels in estuaries.
- Unrestricted flow of freshwater rivers and streams into estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.
- Accumulation and retention of organic material from plants and aquatic animals.
- Unrestricted movement and migration of fish and wildlife.

Conditions Improved

- Restored tidal wetlands, which are highly productive habitats that support biodiversity and provide connectivity between the land and sea.
- Restored coastal embayment that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Improved quality of the water flowing through the estuary.
- Improved connectivity between nearshore and adjacent uplands.
- Increased area, length, and complexity of shoreline.

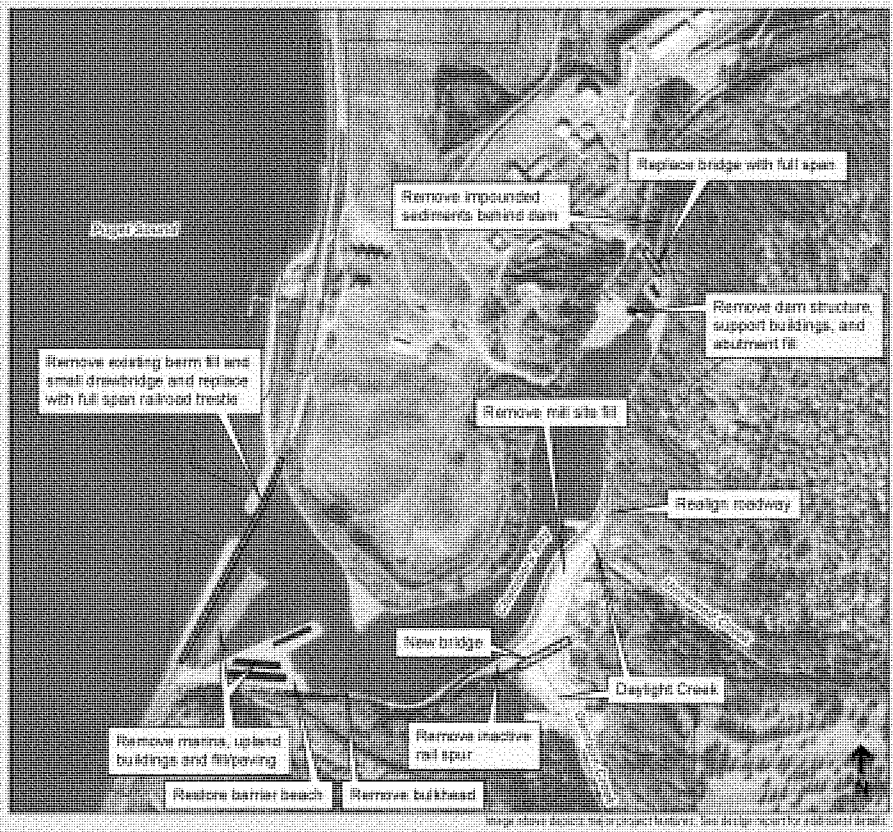


Image above depicts major project features. See design report for additional details.

Key Design Elements

The restoration would remove the dam in the upper estuary to restore tidal flows. The existing railroad berm at the mouth of the estuary would be removed and the trestle would be extended to span the entire inlet (1,400 feet). The inactive railroad tracks also would be removed and Chambers Creek Road would be relocated to the east. Two culverted streams would be daylighted (Garrison Springs Creek and No Name Creek) within the former mill property. A historic barrier beach (located near the marina) would be restored by removing the armor, fill, and marina docks, boathouses and associated structures. In select tidal marsh and riparian areas, invasive species would be removed and native species would be planted.

Site Summary Statistics

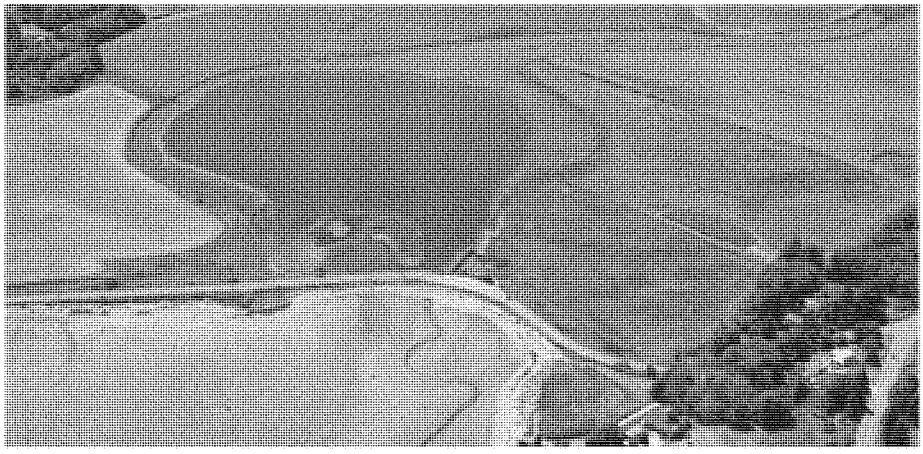
- Area of Restored Process: 90 acres
- Total Project Cost (Mar 2016 Prices): $298,002,000
- Ecosystem Output Score: 8.5



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Dugualla Bay

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT



(IMAGE Washington State Department of Ecology (2006))

Ecosystem Restoration Benefits

- Restore coastal embayment that provides valuable nursery habitat for juvenile threatened salmon species increasing their survival and supporting Puget Sound population recovery.
- Restore intertidal and shallow subtidal areas for recreationally-aud culturally-important shellfish.
- Increase shoreline area, length and complexity.

Significance

- Provides critical estuary habitat in the Whidbey basin, where about 80 percent of estuary habitat is no longer accessible.
- Included in Puget Sound Chinook Salmon Federal Recovery Plan.
- Site will be used by roughly half of the out-migrating North Fork Skagit juvenile salmon.
- Adds more than five times the shoreline length to existing, available nearshore habitat.

Dugualla Bay

www.pugetsoundnearshore.org

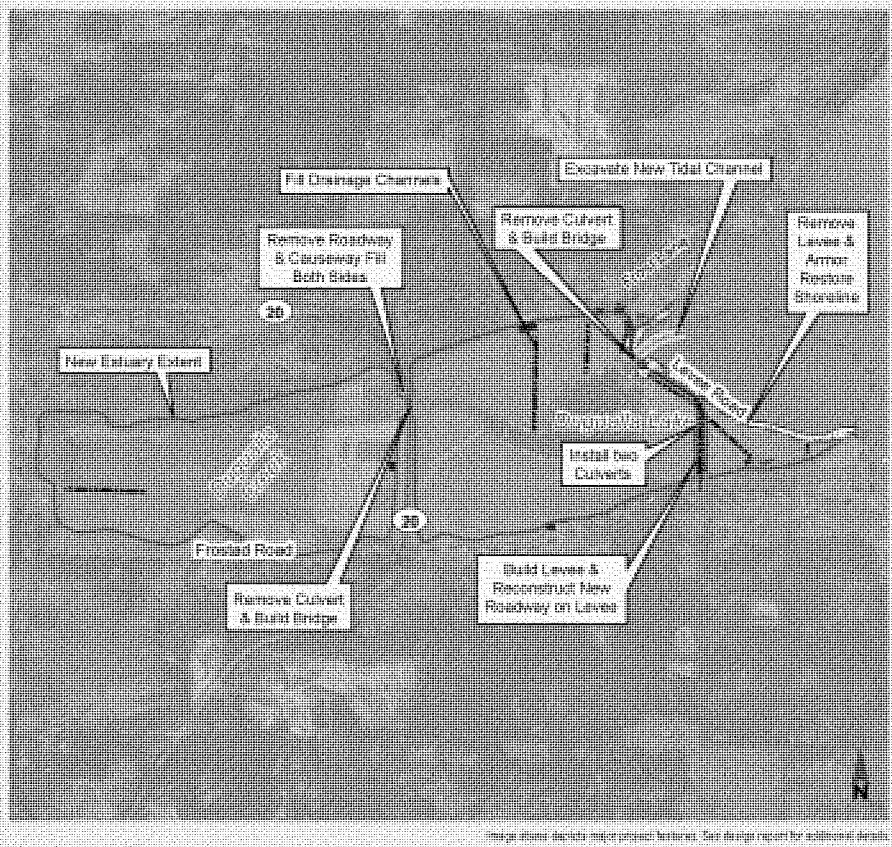


Image above depicts major project features. See design report for additional details.

Key Design Elements

The restoration returns historical tidal inundation to Dugualla Bay by removing the tide gate and pumping system, excavating a shorter channel, and allowing tidal flow into the existing lake. Two barrier beaches, historically defining the tidal channel entrance, will be created and a new 250-foot-long bridge will allow vehicle passage along Diller Road. Portions of the road will also be raised out of the newly inundated floodplain. A 200-foot-long bridge will replace a culvert under State Route 20.

Site Summary Statistics

Area of Restored Process	378 acres
Total Project Cost (Mar 2016 Prices)	$8,855,000
Ecosystem Output Score	162.6



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Everett Marshland

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

The Everett Marshland site is located along Snohomish River's west bank near the Ebey Slough fork. Although in the river's 100-year floodplain, the action area is completely cut off from tidal hydrology by levees and drainage structures, resulted to support agricultural land use. The area is also bisected by a railroad running generally southwest and southeast, with tidally corrected running east and west. This project restores tidal hydrology and channel-forming processes to 825 acres of tidal freshwater wetlands, reconnecting the site to the Snohomish River. This is accomplished by relocating levees and roadways, filling and filling drainage canals, reclaiming tidal channels, and reconnecting streams to the tidal area.



IMAGE: Google Earth (2010)

Ecosystem Restoration Benefits

- Restore highly productive tidal freshwater wetland habitats that support biodiversity and provide connectivity between land and sea.
- Restore large river delta that provides valuable nnrsery habitat for juvenile threatened salmon, increasing their survival and supporting Puget Sound population recovery.
- Improve estuary water quality.
- Increase shoreline area, length and complexity.
- Improve resiliency of the shoreline to respond to changes in the environment such as sea level change and increasing storm events.

Significance

- More than 80 percent of the Snohomish estuary is leveed, with only 18 percent of historical wetlands remaining.
- Provides floodplain forest and swamp wetlands, the most absent from the Snohomish system, and critical for out-migrating fish.
- Located on the Snohomish River's mainstem, the site will benefit all out-migrating fish.
- Builds on previous Federal, state, tribal, local and non-government restoration investments, including Corps projects at Qwuloolt and Union Slough.
- Included in Puget Sound Chinook Salmon Federal Recovery Plan.
- Adds more than three times the shoreline length to existing, available nearshore habitat.

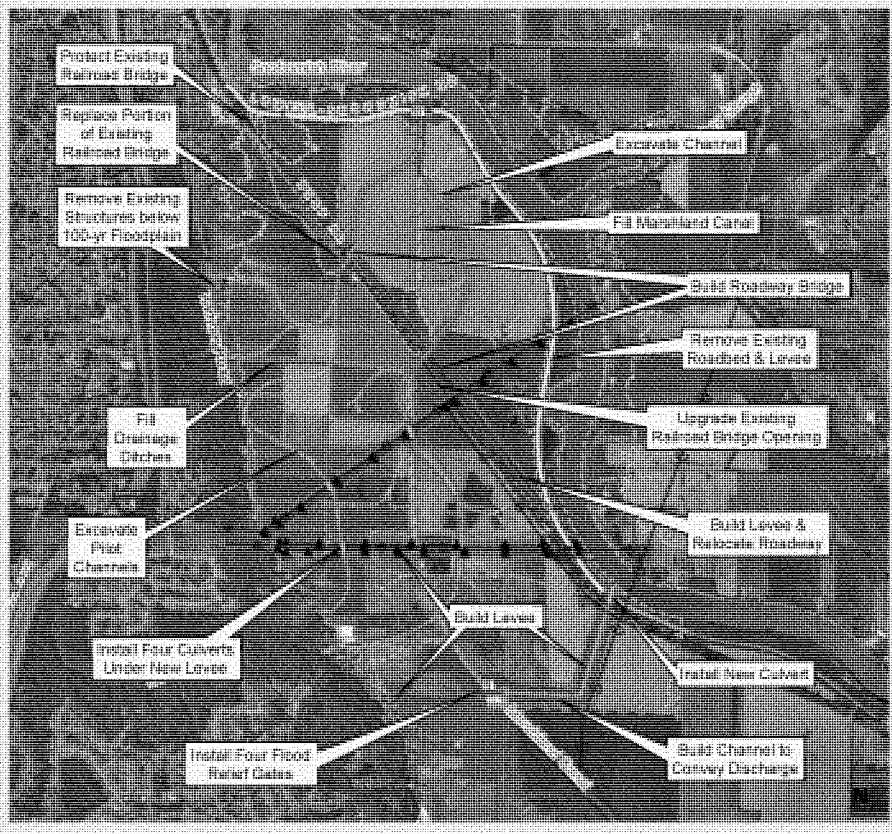


Image shows depicts major project features. See design report for additional details.

Key Design Elements

The restoration removes 1.5 miles of levee along the Snohomish River and Lowell-Snohomish River Road, which re-introduces tidal influence to diked farmlands. The road will align with the railroad and multiple new bridges will allow tidal flow beneath the road and railroad embankment. The Marshland Pump Station and flood gates will relocate to the site's south end. Excavation of multiple starter channels in the area will initiate tidal slough channel development. New levees will protect regional transmission lines and gas pipelines west of the railroad line.

Site Summary Statistics

Area of Restored Process:	829 acres
Total Project Cost (Mar 2016 Prices): :	$296,905,000
Ecosystem Output Score:	349.3



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)

SITES FOR ADDITIONAL STUDY

Lilliwaup River Estuary

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

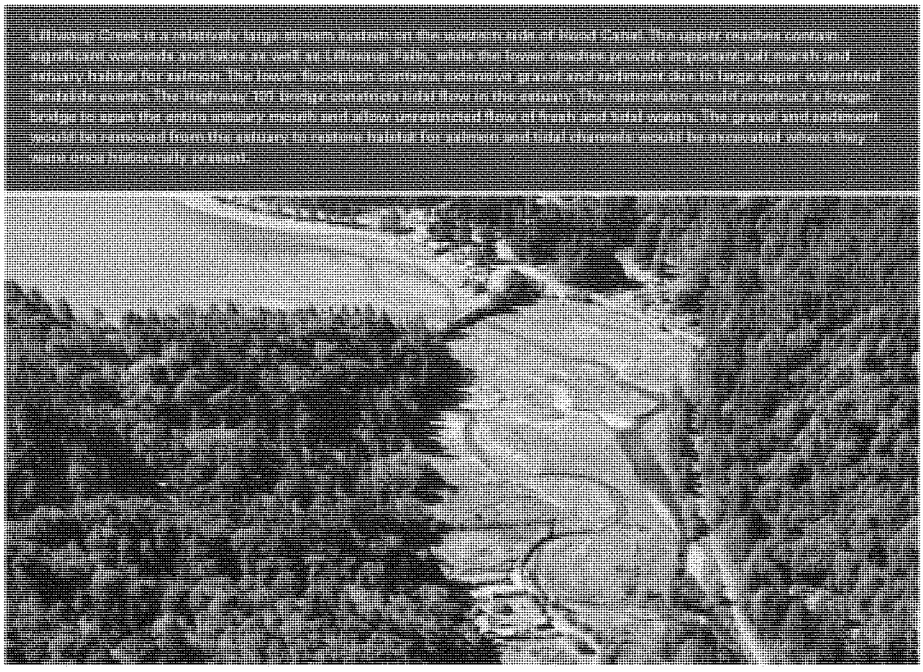


IMAGE: Washington State Department of Ecology (2006)

Processes Restored

- Natural erosion and accretion of beaches.
- Natural formation of tidal channels in estuaries.
- Unrestricted flow of freshwater rivers and streams into estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.
- Accumulation and retention of organic material from plants and aquatic animals.
- Unrestricted movement and migration of fish and wildlife.

Conditions Improved

- Re-established historic tidal flat habitats that are important foraging and resting areas for large flocks of shorebirds, such as Dunlin, as well as other marine birds like Great Blue Heron.
- Restored coastal embayment that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Improved connectivity between nearshore and adjacent uplands.
- Improved resiliency of the shoreline to respond to changes in the environment such as sea level change and increasing storm events.

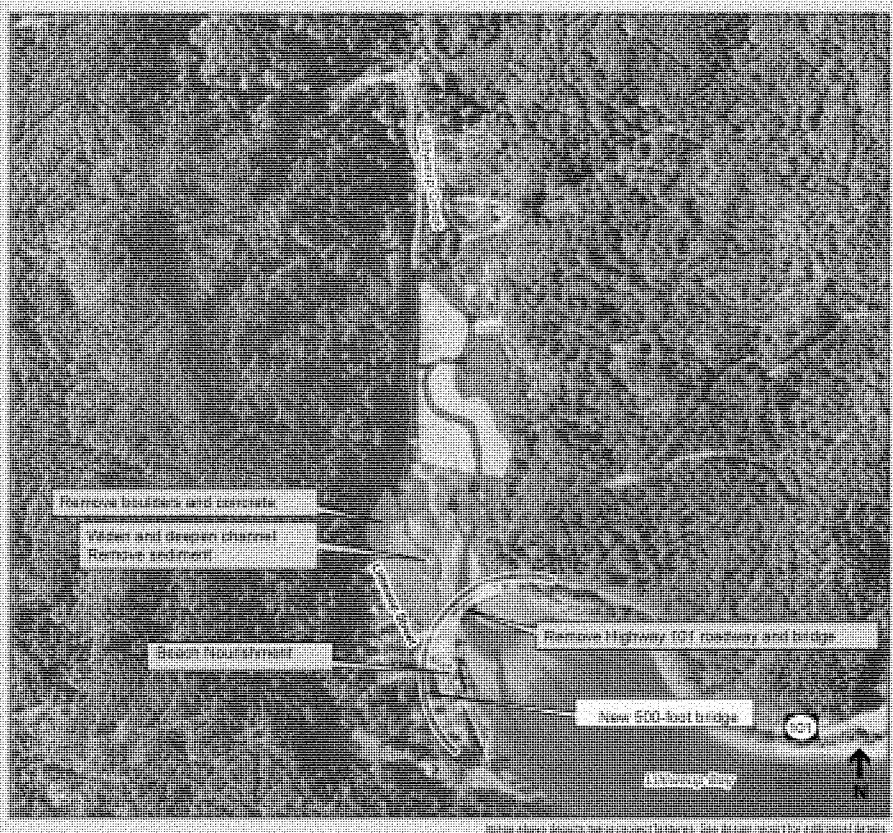


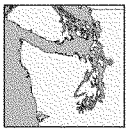
Image shows depicts major project features. See design report for additional details.

Key Design Elements

The project would restore tidal flow and connectivity to Lilliwaup Creek by removing the current bleachage associated with Hwy 101 and replacing with a longer span (500ft) bridge. The accumulated gravel and sediment would be removed from the tidal channels. Lilliwaup Street would be rebuilt to meet the new bridge alignment and beach nourishment would be added to the western shore.

Site Summary Statistics

Area of Restored Process:	19 Acres
Total Project Cost (Mar 2016 Prices):	$36,994,000
Ecosystem Output Score:	1.13



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Snohomish River Estuary

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

The Snohomish River Estuary is the second largest estuary in Puget Sound, providing critically important spawning and rearing habitat for salmon, shellfish, and fish. The lower estuary is intensely utilized numerous tidal channels and extensive mudflats, habitats, and dining, filling, and dredge disposal have resulted in the loss of some of these important areas. Extensive habitat restoration is a cornerstone of the Snohomish Basin salmon recovery strategy. The project will restore and enhance connectivity between the Snohomish River mainstem and side channel habitat by removing fill, restored and relocating levees. The project includes two major elements: a tributary channel near Dagger's Marina, and a tidal slough mouth of Langus Riverfront Park.

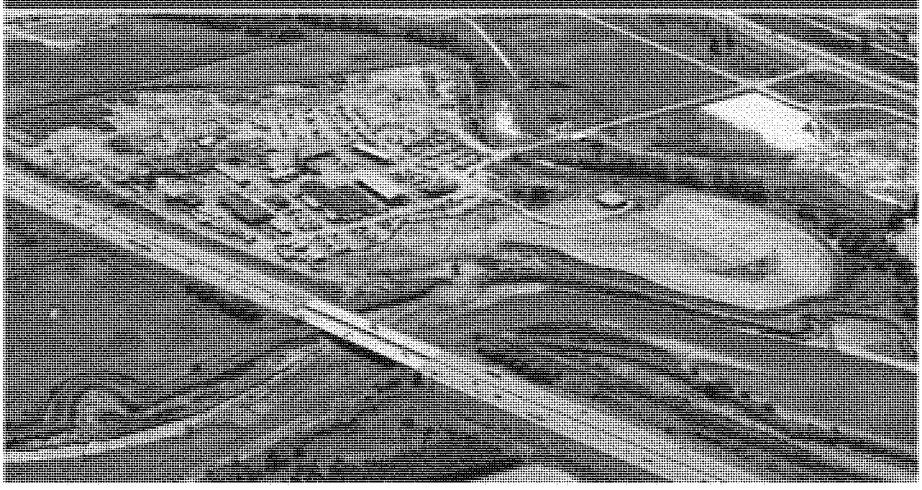


IMAGE: Washington State Department of Ecology (2006)

Processes Restored

- Natural formation of tidal channels in estuaries.
- Unrestricted flow of freshwater rivers and streams into estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.
- Unrestricted movement and migration of fish and wildlife.

Conditions Improved

- Restored large river delta that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Improved quality of the water flowing through the estuary.
- Improved public access to the shore and recreational opportunities.

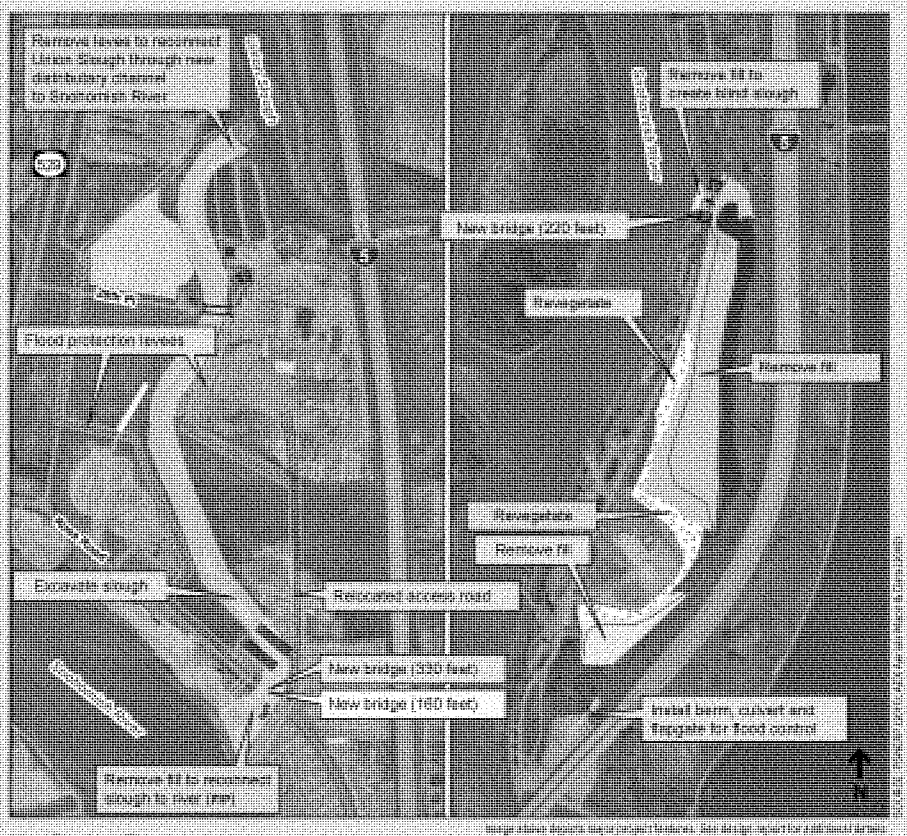


Image above depicts major project features. See design report for additional details.

Key Design Elements

The proposed project alternative would reconnect the distributary channel to Union Slough (at the north end) and the Snohomish River (south end) by removing road fill and the tide gate. Existing levees and additional fill would be removed to allow tidal flows and restore intertidal marsh habitat along the restored channel. An existing access road will be relocated and new levees would be installed along the perimeter of the restored area to protect surrounding areas from flooding. At the blind slough site, road fill would be removed from the mouth of the slough to reconnect it to the Snohomish River. A new bridge across the slough would allow continued vehicle access to the south end of Smith Island. Removal of dredge spoils from the slough would encourage reestablishment of a tidal marsh.

A new berm surrounding the restored marsh would protect adjacent properties including the Everett WWTP facilities from flooding.

Site Summary Statistics

Area of Restored Process:	67.5 Acres
Total Project Cost (Mar 2006 prices):	$126,513,000
Ecosystem Output Score:	17.73



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Tahuya River Estuary

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

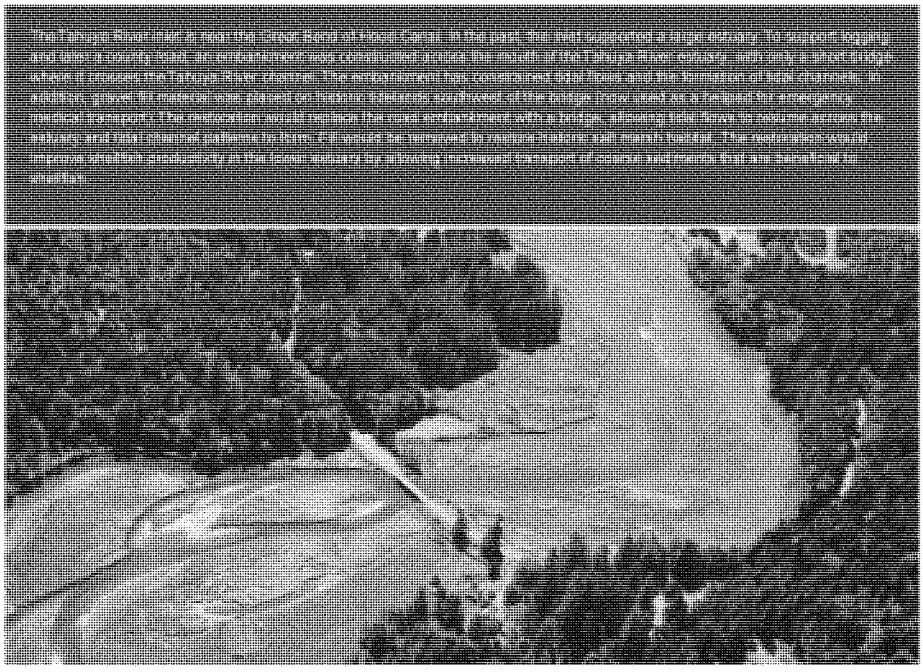


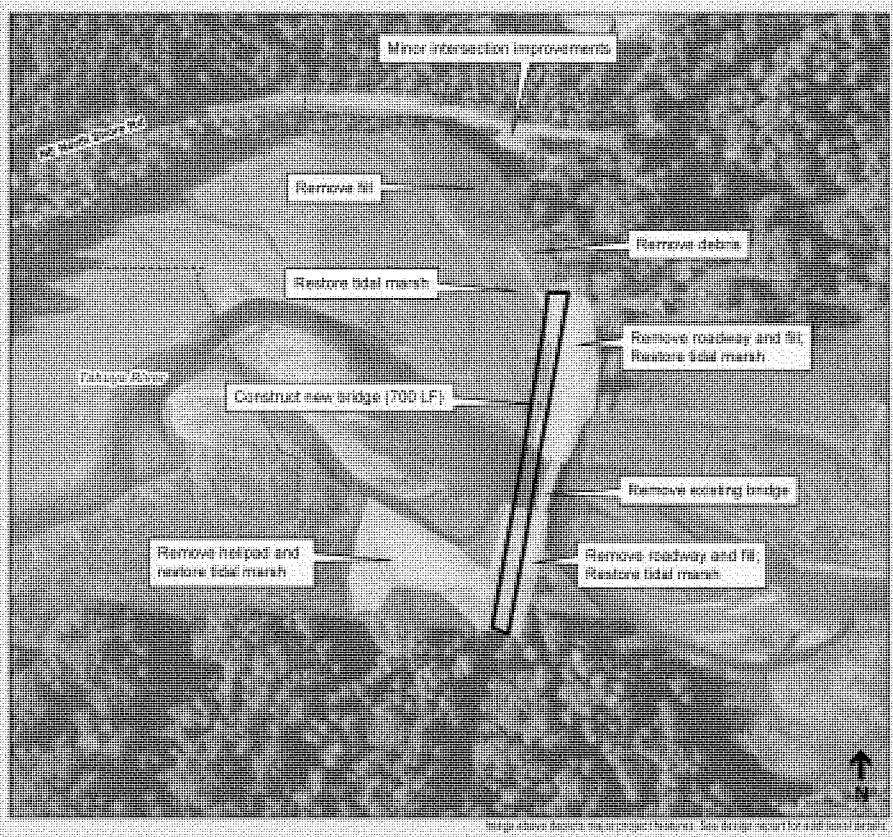
IMAGE: Washington State Department of Ecology (2005)

Processes Restored

- Natural erosion and accretion of beaches.
- Natural formation of tidal channels in estuaries.
- Unrestricted flow of freshwater rivers and streams into estuaries.
- Unrestricted movement of saltwater through tidal channels in estuaries.

Conditions Improved

- Restored coastal embayment that provides valuable nursery habitat for threatened species of juvenile salmon such as Chinook, increasing their survival and supporting population recovery in Puget Sound.
- Restored intertidal and shallow subtidal areas that are habitat for recreationally and culturally important shellfish such as oysters, mussels, and clams.
- Improved quality of the water flowing through the estnary.



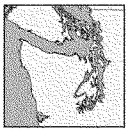
Bridge shown denotes major project features. See design report for additional details.

Key Design Elements

The restoration would remove the entire roadway embankment fill from the estuary, replacing it with a 700-foot-long bridge span. Portions of the NE North Shore Road would be realigned to conform to the new bridge placement. Other fill such as the gravel ballast would also be removed from the intertidal zone. In areas where fill is removed, the marsh would be restored by decompacting the soil and installing native plant species.

Site Summary Statistics

• Area of Restored Process	[illegible] acres
• Total Project Cost (Mar 2008 Prices)	$10,300,000
Ecosystem Output Score	7.6



PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP)
SITES FOR ADDITIONAL STUDY

Telegraph Slough

PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT

Telegraph Slough is located in a 4-mile long tidal channel that connects Skagit and Padilla Bays. Major regional road and railroad transportation corridors and utility infrastructure limit the ability to restore tidal inundation. Historically, thousands of acres of tidal wetland habitat in the Skagit River delta, although dominated by the Fir Island/Port Susan system, also included Telegraph Slough and other distributary channels and tidal flats. Conversion of these areas to farmland and flooding by dikes and tidegates has degraded the ecological functions of the Skagit River delta. Restoration of tidal exchange to Telegraph Slough would restore habitat for juvenile salmon and other species. Tidal inundation would also restore habitat for migratory waterfowl. Current studies by the Skagit River System Cooperative (SRSC) are investigating the feasibility of restoring tidal exchange to Telegraph Slough. This project would be located near Farmhouse and Allen Creek. Restoring juvenile salmon habitat in Telegraph Slough would also contribute to Padilla Bay, a National Estuarine Research Reserve with the largest existing Puget Sound eelgrass meadow. Restoration of Telegraph Slough is a priority for the Skagit Watershed Council (SWC) and the Skagit River System Cooperative (SRSC). Both organizations have been actively involved in collecting and analyzing current and modeling data for the project.

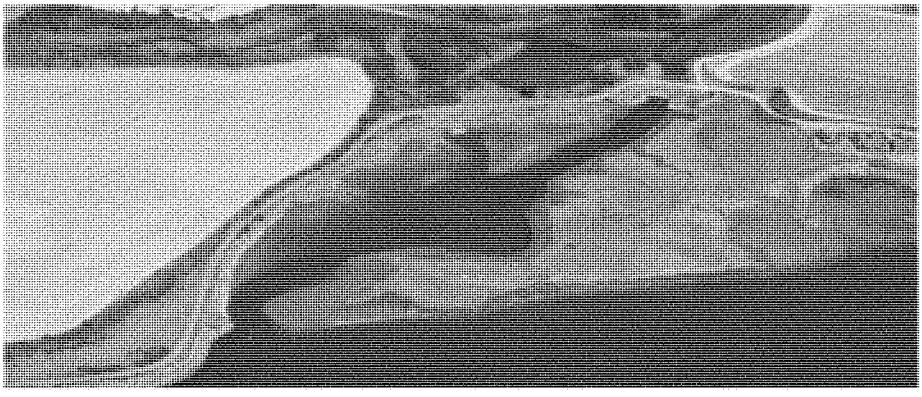


IMAGE: Washington State Department of Ecology (2006)

Ecosystem Restoration Benefits

- Restore large river delta that provides valuable nursery habitat for juvenile threatened salmon species, increasing survival and supporting Puget Sound population recovery.
- Restore sand and gravel beaches that serve as spawning grounds for forage fish, such as surf smelt and Pacific sand lance, key elements of the marine food chain.
- Re-establish intertidal and shallow subtidal areas to encourage kelp and eelgrass growth, increasing nearshore productivity for fish, birds and other marine species.

Significance

- Opens another fish pathway into Padilla Bay, a National Estuarine Research Reserve with the largest existing Puget Sound eelgrass meadow.
- Provides restoration beneficial to fish and wildlife using the North Fork Skagit River, where opportunities are limited.
- Included in the Puget Sound Chinook Salmon Federal Recovery Plan.
- Increases juvenile salmon rearing habitat.
- More than doubles existing nearshore shoreline habitat available.

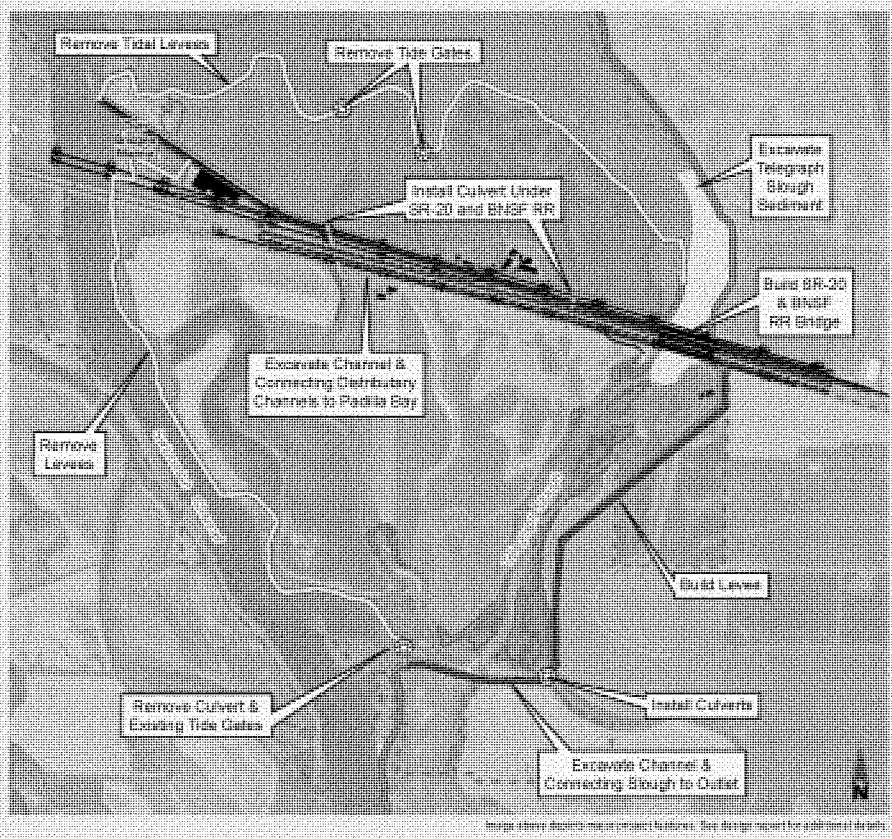


Image shows design elements of project features. See design report for additional details.

Key Design Elements

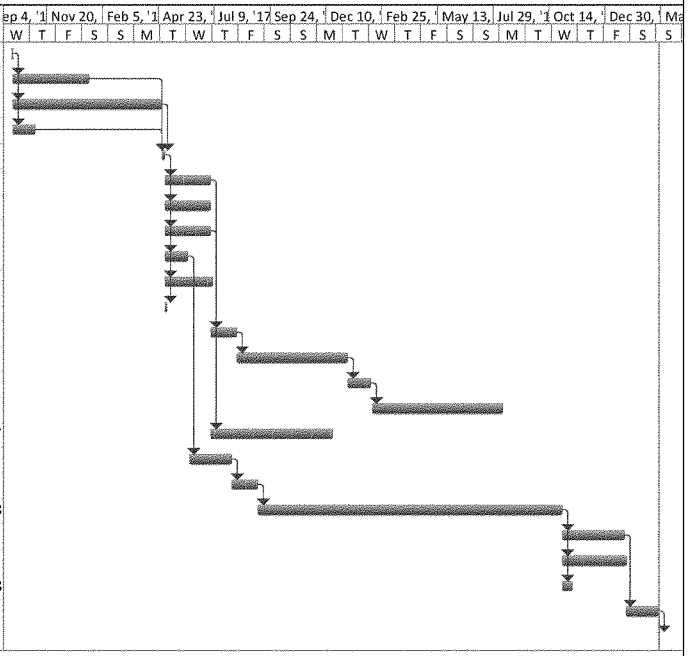
The restoration removes most of the levees along Telegraph Slough, Padilla Bay and eastern Swinomish Channel. Levee removal requires raising the railroad and State Route 20 between Swinomish Channel to Telegraph Slough to keep them above the inundation and wave action limits. The railroad and State Route 20 will cross the Slough on elevated long-span bridges. A new levee along east and south Telegraph Slough will contain flood flows and extreme tides. Levee removal restores about 832 acres of former salt marsh to tidal influence.

Site Summary Statistics

Area of Restored Process:	832 acres
Total Project Cost (Mar 2016 Prices):	$[illegible]24,000
Ecosystem Output Score:	253.9

PSNERP
Dugualla Bay
Construction Schedule

ID	Task Name	Duration	Start	Finish
1	Start	1 day	Mon 10/3/16	Mon 10/3/16
2	Cultural Resources	75 days	Tue 10/4/16	Mon 1/16/17
3	Site Survey	148 days	Tue 10/4/16	Thu 4/27/17
4	Erosion Control	23 days	Tue 10/4/16	Thu 11/3/16
5	Clear and Grub	2 days	Fri 4/28/17	Mon 5/1/17
6	SR-20 Road Berm	45 days	Tue 5/2/17	Mon 7/3/17
7	Building Demo	45 days	Tue 5/2/17	Mon 7/3/17
8	Buildind Utilty Demo	45 days	Tue 5/2/17	Mon 7/3/17
9	Dike Road Pavement Demo	24 days	Tue 5/2/17	Fri 6/2/17
10	Dike Road Utility Demo	48 days	Tue 5/2/17	Thu 7/6/17
11	Demo Tide Gate	3 days	Tue 5/2/17	Thu 5/4/17
12	Rebuild SR-20	26 days	Tue 7/4/17	Tue 8/8/17
13	SR-20 Bridge	109 days	Wed 8/9/17	Mon 1/8/18
14	SR-20 Pavement Demo	24 days	Tue 1/9/18	Fri 2/9/18
15	SR-20 Berm Removal	130 days	Mon 2/12/18	Fri 8/10/18
16	Utility Installation	120 days	Tue 7/4/17	Mon 12/18/17
17	Shoreline Dike (Road Berm)	42 days	Mon 6/5/17	Tue 8/1/17
18	Dike Road Rebuild	26 days	Wed 8/2/17	Wed 9/6/17
19	Dike Road Bridge	300 days	Thu 9/7/17	Wed 10/31/18
20	Revegetation	62 days	Thu 11/1/18	Fri 1/25/19
21	Shoreline Dike Demo	63 days	Thu 11/1/18	Mon 1/28/19
22	Fill Ditches	10 days	Thu 11/1/18	Wed 11/14/18
23	Beach Nourishment	33 days	Mon 1/28/19	Wed 3/13/19
24	Finish	1 day?	Thu 3/14/19	Thu 3/14/19



Project: Dugualla Bay
Date: Fri 3/25/16

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
	PROJECT & PROGRAM MGMT								
PPM-1	Project Scheduling	High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.	PDT does not believe the volume of project will cause problems. Project will be schedule over years and even decades in order to meet construction goals.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-2	Staffing Reductions	Both the Seattle District and the WDFW have numerous projects competing for staffing resources. If other projects become a higher priority staff could be pulled from PSNERP.	PSNERP remains a District and WDFW priority and will is less likely than other projects to see staffing reductions. There are minor cost increases due to increases in work being out-sourced to AEs and potential slowdowns is staffing is shifted on short notice.	Unlikely	Marginal	LOW	Very Unlikely	Negligible	LOW
PPM-3	Communication Issues	Excellent communications is necessary in order to successfully complete the project. Both internal issues intra-Corps or intra-WDFW, or issues between the Corps and local sponsors could affect the project timeline.	The project currently has strong communication and trust between the Corps and WDFW, and enjoys high levels of political support both from the Federal and local sponsors. There are other local sponsors (municipalities, tribes, NGOs, etc.) that will be involved once the project moves into PED/CG phase. Communications with these entities may be more fraught and there are likely to be at least some schedule delays because of this.	Very Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-4	Poor Initial Project Performance	The PSNERP project will be very visible in the Puget Sound area once construction begins. Could an early action that performs poorly (reduced environmental benefits, project neighbors who felt slighted or whose concerns were not fully addressed, etc.) cause the remainder of the project to have increased cost/schedule?	PDT believes its very unlikely that there would be a poorly performing initial project as the earliest projects that proceed to construction are likely to be those whose success is the most assured. Impacts would likely be delays to the start of projects, and costs other than increases due to inflation would be unlikely.	Very Unlikely	Negligible	LOW	Very Unlikely	Marginal	LOW
PPM-5	Authorization at 10% Design	Project is going forward for authorization at a 10% design level. Usually TSP is done at the 35%. Unknown elements may increase cost and schedule.	This is a very likely risk. Contract costs could increase substantially if this project is not awarded until 2020. However, authorized funding is adjusted for inflation, and the impacts due to delay are mitigated somewhat because of this.	Very Likely	Significant	HIGH	Very Likely	Negligible	LOW
				Project Cost			**Project Schedule**		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	CONTRACT ACQUISITION RISKS								
CA-1	Small Business Markups	The Seattle District has goals for allocating projects to small businesses, women/minority/veteran owned businesses, and other historically underutilized groups and areas. Costs could increase due to a restricted bidding environment and higher contractor markups.	Project size to a certain degree drives whether or not a project will go to restricted bidding. Anything under $20M is very likely to be restricted, over $30M will likely be full and open, and anything in-between could go either way. During the estimating process all contracts were assumed to be advertised to small businesses only. Its possible that projects between $20-30M could see cost reductions, and it's very likely that projects over $40M will see reductions.	Unlikely	Critical	MODERATE	Very Unlikely	Negligible	LOW
CA-2	Inefficient Contractors	The acquisition process may higher inefficient contractors	PDT believe that this is unlikely. Contracting language and selection processes can be done in a way that can filter out poor performing contractors	Very Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
				Project Cost			**Project Schedule**		

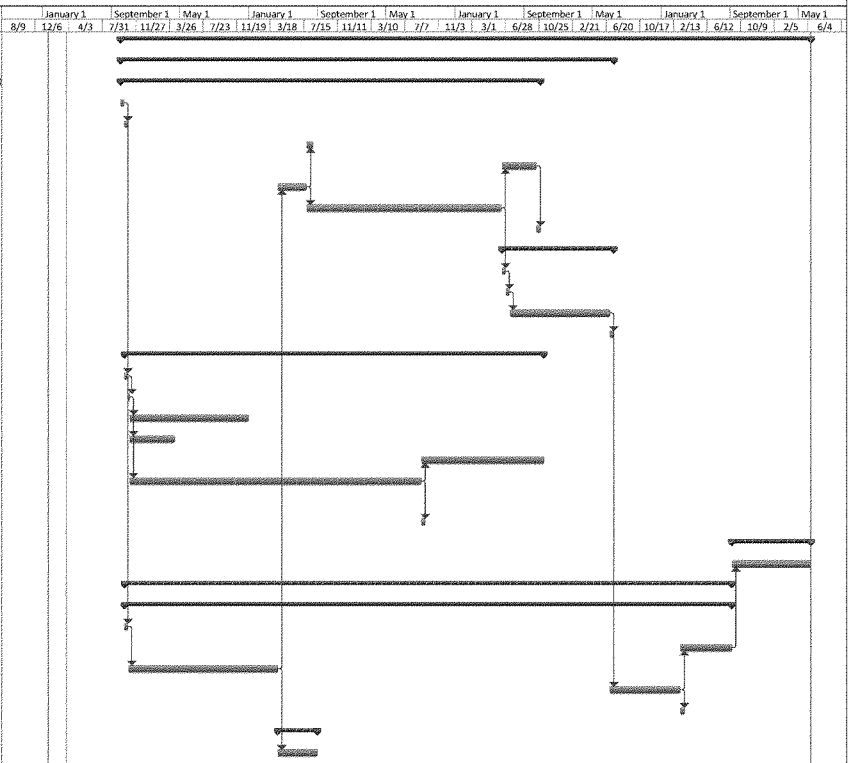
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	TECHNICAL RISKS								
TL-1	Changes to levee design	Levee design changes due to limited geotechnical knowledge.	PDT believes that there is a high likelihood of the increased levee scope due to limited knowledge of geotechnical conditions. Levee settlement is the biggest concern. Impact to cost would be significant.	Likely	Significant	HIGH	Likely	Significant	HIGH
TL-2	Levee Settling	Potential of levee elevation change due to settling.	Current levee design does not account for the potential of any levee settling. Area is known to be marsh land and there is high risk of mitigation, substantial redesign, or other work being required to change the berm itself or to fix utilities if the break. Assume an increase in costs to have to go back demo a portion of the roadway, fix the utilities, add fill, and reinstall the road. Potential significant impact on cost. Per NWS Soils, a 30% increase in soil costs is possible.	Very Likely	Significant	HIGH	Very Likely	Critical	HIGH
TL-3	Demo tide gate structure	Conditions at the area are unknown. Estimators assumptions were used to determine production and method.	Since almost everything is unknown about this feature of work, it is very likely there will be increases. Any likely change would have a negligible impact on costs.	Very Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
TL-4	On-Site Borrow	Could on-site borrow be used to fulfill some or all of the levee fill requirements?	The PDT does not believe this is a possible opportunity. The only possible source would be the fill from the existing levees, but the new setback levees must be installed prior to removal of the existing levees.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
TL-5	Additional Drainage Requirements	There are limited drainage features through the levee. Could additional gates be required?	PDT believes this risk is likely. There may be a possible 10% cost adjustment to the levees for additional drainage features.	Likely	Critical	HIGH	Likely	Negligible	LOW
TL-6	Deeper Bridge Piers	Bridge designs were not adjusted for each individual site, but are a common design. Is this appropriate for Dugualla with its more marginal subsurface conditions?	NWS Soils believe piers may need to extend an additional 50' for all bridge items. Additionally, more scour protection could be required at the base of bridge piers.	Very Likely	Significant	HIGH	Very Likely	Marginal	MODERATE
				Project Cost			**Project Schedule**		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	LANDS AND DAMAGES RISKS								
LD-1	Hostile landowners	Unwilling landowners who do not want to sell land or provide easements could drive up costs.	If landowners are unwilling to sell, the action may not move forward. A more likely scenario is that a few landowners are not willing to sell and some mitigation will need to be done in order to protect their property from inundation. PDT believes that there is a high likelihood of unwilling sellers, and the most likely mitigation would be to construct additional dikes. 1000' of additional dike would raise costs into the significant range.	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
LD-2	Relocations	Is it possible that relocations may not have been completed by the time construction started, potentially delaying projects. Additionally, H&H modelling has not been done for all sites. Could higher calculated water lines affect additional properties?	Relocations not being completed is very unlikely as all projects must have their real estates objectives met prior to construction starting. The potential for increased affected areas is likely and contains significant costs. Primarily this is due to utilities as increased costs for property relocations is captured in the real estate contingency.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
LD-3	Vagrancy/Loitering	Could vagrants on the project site slow the project?	Very unlikely. Most sites are well away from large populated areas and are not likely to contain transient populations.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	REGULATORY AND ENVIRONMENTAL RISKS								
RE-1	Contaminated Drainage Fields	Potential leaking pipes/contaminated drainage fields releasing sanitary waste.	Likely that this would occur, but it would be at low concentrations and volumes. Negligible increase in cost.	Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
RE-2	Building HTRW	Buildings have not been surveyed for HAZMAT materials. As many of the buildings are older there may be a potential for asbestos, lead, or other materials.	PDT believes this is very likely to occur, but there is standard procedures to deal with these problems. Marginal cost increase.	Very Likely	Marginal	MODERATE	Unlikely	Marginal	LOW
RE-3	Petroleum Compounds in Road Dikes	Years of driving on existing road berms may have lead to petroleum contamination.	It is very likely that leaking vehicles have contaminated small (relative to total volume) amounts of soil and base course. Material would need to be excavated and disposed of properly. Negligible cost increase for all dikes.	Very Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
RE-4	Contamination from NAS Whidbey	NAS Whidbey is reported to have possibly spilled petroleum in the area.	Very high likelihood of finding low level petroleum contamination. Material would need to be excavated and disposed of properly. Marginal cost increase.	Very Likely	Marginal	MODERATE	Very Unlikely	Negligible	LOW
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	CONSTRUCTION RISKS								
CON-1	Building Demolition	Building construction is assumed light frame and foundation. Heavier structures would be more difficult to demolish and remove.	High likelihood of at least some of the buildings on-site being heavier construction than this. A 20% increase in cost due to more complicated building construction would have a negligible impact on total project cost.	Very Likely	Negligible	LOW	Very Likely	Negligible	LOW
CON-2	Equipment Accessibility	Production rate is dependent on soil conditions suitable for equipment travel.	If soil is saturated or has other issues travel in the areas where channels are being excavated will be difficult. While weather days are included in the schedule, rain at any time could so saturate the soil that it is unworkable for time past the actual weather event. Also, if conditions are inherently unsuitable changes in work methods will be required. A 25% production rate slowdown, would have a significant increase on costs.	Likely	Significant	HIGH	Likely	Significant	HIGH
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	ESTIMATE AND SCHEDULE RISKS								
EST-1	Earthwork Construction	Site conditions were assumed appropriate to bring in large scale equipment. Changes in this would affect size of equipment and thus production.	If weather and soil conditions are not suitable for large equipment, smaller pieces will need to be brought in, or an access road will need to be built. A 20% slowdown in production will increase levee removal and install costs. This would have a marginal impact on overall cost.	Likely	Critical	HIGH	Likely	Negligible	LOW
EST-2	Fish Windows	In-water work windows control a certain portion of the schedule and may drive overall construction duration.	Existing levee work occurs in or near the river. In-water work is a relatively narrow window. It may not be possible for a contractor to complete all the work necessary in a single season, necessitating multiple mob/demobs and lost efficiency.	Likely	Negligible	LOW	Likely	Crisis	HIGH

EST-3	Fuel Cost Increases	Fuel cost increases above expected rates will contribute to total project costs.	Fuel costs for the machinery and the hauling. An increase of 25% in fuel costs increases the total project cost less than 0.5%	Likely	Significant	HIGH	Very Unlikely	Negligible	LOW
EST-4	Speculative Earthwork Quantities	Earthwork quantities were entirely developed through aerial surveys. Removal costs may increase	The PDT believes that it is very high likely that there will be additional quantities due to margin of error inherent in aerial surveys. Errors may be present in shoreline dike removal, SR-20 berm removal, Dugualla Lake berm removal, and beach nourishment placement.	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
EST-5	Beach Fill Haul	It is assumed in the estimate, that trucks will be able to access the area to deposit fill. If this is not possible and material must be unloaded and then reloaded into equipment that can access the site	At present, conditions are expected to allow trucks to access the site, so this risk is unlikely to occur	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
EST-6	Estimator Assumptions	As the project drawings were only completed to a 10% level, the estimator made a variety of assumptions regarding items such as utility installation, site access points, and overall production. At higher level of detail, these assumptions may be revised.	Assumptions were generally conservative, but there is definitely potential for cost movement on these items. Some manner of cost impact should be considered likely.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
				Project Cost			**Project Schedule**		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-1	Transmission Utility Demolition	The utilities along Dike Road are generally transmission systems that feed whole communities south of the current road. Could special requirements be placed on their demolition?	It's highly likely that disconnecting the current utilities and attaching them to alternate lines would have to be done at off hours. This costs associated with this would be primarily increased labor rates due to construction at unusual times. Negligible overall impact to project cost.	Very Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
PR-2	Presence of Unknown Utilities	Site has not been analyzed for many utilities. Their presence could increase cost and schedule	High likelihood of additional power lines being present. If found, could be either reinforced or relocated. Negligible effect on cost.	Very Likely	Negligible	LOW	Very Likely	Negligible	LOW
PR-3	Historical Buildings	The state historical preservation office will do an evaluation of all buildings at the site to determine whether any form of preservation will be required.	NWS Built Environment archaeologists believes that there is a high potential that one of the buildings would be significant (listed in the National register). Shouldn't have any delays since it will be done before construction. Avoidance would be the best option, but this could require additional berm construction. 1000' of additional berm would have a significant impact on overall cost.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
PR-4	Changing Laws/Regulations	Laws, regulations, and guidelines could change over the life of the project, potentially requiring changes in materials used on sites, adjusted construction methodology, or increased design/study requirements.	In general this risk was viewed to be very unlikely to affect the project. The only exception is that the WA Dept. of Ecology may change its sediment management guidelines. However, these changes are not expected to require more than extremely minor adjustments to TPC.	Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PR-5	Presence of Historical Artifacts	Potential for archaeological finds.	Corps Archeologist reports a moderate (likely) chance of finding cultural artifacts within the action area. They believe costs may be significant if found.	Likely	Significant	MODERATE	Likely	Marginal	MODERATE
PR-6	Changing Laws/Regulations	Laws, regulations, and guidelines could change over the life of the project, potentially requiring changes in materials used on sites, adjusted construction methodology, or increased design/study requirements.	In general this risk was viewed to be very unlikely to affect the project. The only exception is that the WA Dept. of Ecology may change its sediment management guidelines. However, these changes are not expected to require more than extremely minor adjustments to TPC.	Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW

PSNERP
Everett Marshland
Construction Schedule

ID	Task Name	Duration	Start	Finish
1	**Start**	**1747 days**	**Mon 10/3/16**	**Tue 6/13/23**
2	**Relocations**	**1249 days**	**Mon 10/3/16**	**Thu 7/15/21**
3	**Roads**	**1063 days**	**Mon 10/3/16**	**Wed 10/28/20**
4	Mobilize	10 days	Mon 10/3/16	Fri 10/14/16
5	Survey	10 days	Mon 10/17/16	Fri 10/28/16
6	Road Demo	16 days	Tue 7/24/18	Tue 8/14/18
7	Bridge Demo	88 days	Mon 6/15/20	Wed 10/14/20
8	Road Installation	72 days	Fri 4/13/18	Mon 7/23/18
9	Bridge Installation	494 days	Tue 7/24/18	Fri 6/12/20
10	Demobilization	10 days	Thu 10/15/20	Wed 10/28/20
11	**Railroads**	**284 days**	**Mon 6/15/20**	**Thu 7/15/21**
12	Mobilize	10 days	Mon 6/15/20	Fri 6/26/20
13	Survey	10 days	Mon 6/29/20	Fri 7/10/20
14	Bridge Installation	254 days	Mon 7/13/20	Thu 7/1/21
15	Demobilization	10 days	Fri 7/2/21	Thu 7/15/21
16	**Utilities**	**1061 days**	**Mon 10/17/16**	**Mon 11/9/20**
17	Mobilize	10 days	Mon 10/17/16	Fri 10/28/16
18	Survey	4 days	Mon 10/31/16	Thu 11/3/16
19	Distribution Utilities	301 days	Fri 11/4/16	Fri 12/29/17
20	BPA Transmission Line	113 days	Fri 11/4/16	Tue 4/11/17
21	Pump Station Removal	310 days	Tue 9/3/19	Mon 11/9/20
22	Pump Station Construction	737 days	Fri 11/4/16	Mon 9/2/19
23	Demobilization	10 days	Tue 9/3/19	Mon 9/16/19
24	**Fish & Wildlife**	**200 days**	**Wed 9/7/22**	**Tue 6/13/23**
25	Vegetation	200 days	Wed 9/7/22	Tue 6/13/23
26	**Levees & Floodwalls**	**1537 days**	**Mon 10/17/16**	**Tue 9/6/22**
27	**Levee Installation**	**1537 days**	**Mon 10/17/16**	**Tue 9/6/22**
28	Mobilize	10 days	Mon 10/17/16	Fri 10/28/16
29	Fill Ditches	130 days	Wed 3/9/22	Tue 9/6/22
30	Setback Levess	379 days	Mon 10/31/16	Thu 4/12/18
31	Remove Levees	178 days	Fri 7/2/21	Tue 3/8/22
32	Demobilization	10 days	Wed 3/9/22	Tue 3/22/22
33	**Floodway Control & Diversion**	**100 days**	**Fri 4/13/18**	**Thu 8/30/18**
34	Diversion Structure	100 days	Fri 4/13/18	Thu 8/30/18



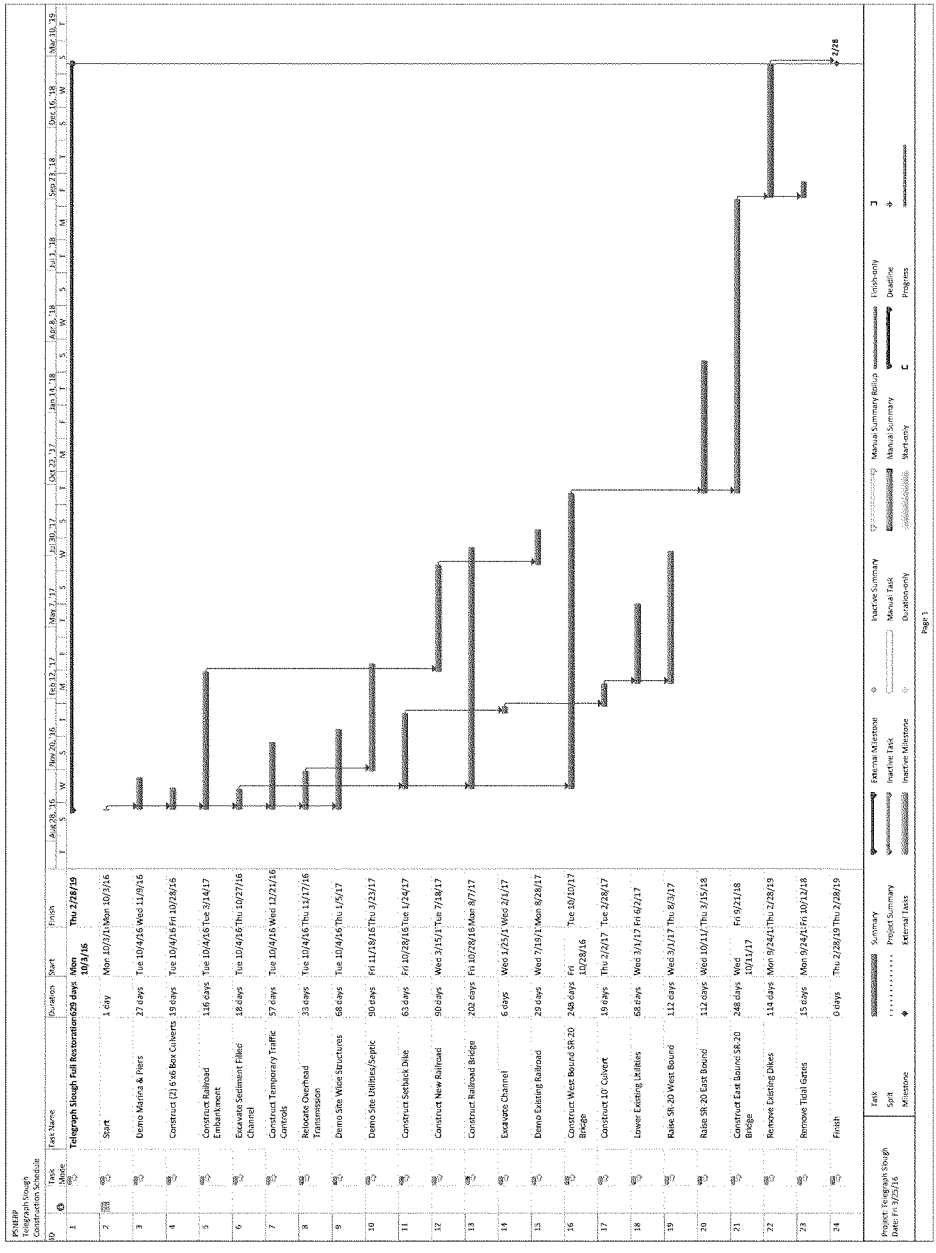
Project: Everett Marhsland
Date: Fri 3/25/16

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only
Summary	Inactive Task	Duration-only	Finish-only

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PROJECT & PROGRAM MGMT									
PPM-1	Project Scheduling	High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.	PDT does not believe the volume of project will cause problems. Project will be schedule over years and even decades in order to meet construction goals.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-2	Staffing Reductions	Both the Seattle District and the WDFW have numerous projects competing for staffing resources. If other projects become a higher priority staff could be pulled from PSNERP.	PSNERP remains a District and WDFW priority and will is less likely than other projects to see staffing reductions. There are minor cost increases due to increases in work being out-sourced to AEs and potentiall slowdowns is staffing is shifted on short notice.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-3	Communication Issues	Excellent communications is necessary in order to sucessfully complete the project. Both internal issues intra-Corps or intra-WDFW, or issues between the Corps and local sponsors could affect the project timeline.	The project currently has strong communication and trust between the Corps and WDFW, and enjoys high levels of political support both from the Federal and local sponsors. There are other local sponsors (municipalities, tribes, NGOs, etc) that will be involved once the project moves into PED/CG phase. Communications with these entities may be more fraught and there are likely to be at least some schedule delays because of this.	Very Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-4	Poor Initial Project Perfomance	The PSNERP project will be very visible in the Puget Sound area once construction begins. Could an early action that performs poorly (reduced environmental benefits, project neighbors who felt slighted or whose concerns were not fully addressed, etc) cause the remainder of the project to have increased cost/schedule?	PDT believes its very unlikely that there would be a poorly performing initial project as the earliest projects that proceed to construction are likely to be those whose success is the most assured. Impacts would likely be delays to the start of projects, and costs other than increases due to inflation would be unlikely.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
CONTRACT ACQUISITION RISKS									
CA-1	Potenially Could Go Small Business	This estimate assumes SB open acquisition. The prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from SB open competition. The size of this project is very large. The project will probably be constructed under multiple acquisitions.	Typically if a project goes very restrictive small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. Given the nature of this work it is felt that it could go small business. Also, other methods may be used as well. It is considered likely that the contracting method could change from what is proposed in the estimate. The impact could be up to 10%	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
CA-2	Railroad Bridge Placement Contracting	Uncertainly on who would execute this work. Would it be USACE or the railroad?	If railroad handles the contract there is potential for cost increases.	Likely	Critical	HIGH	Very Unlikely	Negligible	LOW
CA-3	Inefficient Contractors	The acquisition process may higher inefficient contractors.	PDT believe that this is unlikely. Contracting language and selection processes can be done in a way that can filter out poor performing contractors.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
TECHNICAL RISKS									

TL-1	Earthwork - Lack of Details	Limited work was done to determine the requirements that would be placed on the levees. Additional analysis may increase SOW.	There is the possibility that the areas of excavation and fill could change from what is presented in the draft report. Any increase in quantity will be covered in the Quantity risk element section. The risk here is that the nature of the earthwork may change. There could be additional requirements (not quantities) imposed in the excavation and fill. It is thought to be at least a 50% chance that the scope of the earthwork will change. Any changes in scope could easily increase the cost for this item by 2%. That would translate to 1% increase in TPC.	Likely	Significant	HIGH	Very Likely	Critical	HIGH
TL-2	Pump Station	No information is known for the demolition or installation of the pump station.	The only item used for estimating this item was an aerial photograph for demolition. It is very likely that scope will change for this item because there is currently no scope provided. This item has a critical impact given the potential for cost growth. Pumps, electrical components, SCADA and other components are unknown. PDT mentioned fish passage which increases the requirements of fabrication. There is a very likely risk here. Assume impact is significant.	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
TL-3	Road Bridge Placement	No design. Same typical section used for all of the bridges. Seismic requirements.	The bridge type is likely to change or some elements of the scope of the proposed bridge. The bridge is approximately under 10% of the construction cost.	Likely	Significant	HIGH	Very Likely	Significant	HIGH
TL-4	Railroad Bridge Placement	No design. Typical section used for estimate development. Seismic requirements and tying into existing bridges.	The bridge type is likely to change or some elements of the scope of the proposed bridge. Currently proposed construction methodology is to replace while under use. This will be extremely problemmatic and will likely require rethinking during PED.	Very Likely	Critical	HIGH	Very Likely	Critical	HIGH
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	LANDS AND DAMAGES RISKS								
LD-2	Structure Removal	No details for the structures to be removed.	The PDT noted that there is the possibility of residential relocation. It is as good assumption that it is likely the scope for this item will increase. The impact is assumed to be marginal.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
LD-3	Land Acquisition	Land acquisitions and unwilling property owners. Stakeholder involvement.	This has the potential to change the project scope. Risk captured in the scope risk element.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	REGULATORY AND ENVIRONMENTAL								
RE-2	HTRW - Earthwork	Farming chemicals, containers with residual products.	High potential per PDT meeting. This would require remediation simular to the work in the landfill or creosote facility tasks. Impact could be significant. ---JUNE 2014--- Risk is removed. HTRW issues are a 100% local sponsor responsibility. LERRD crediting is not applicable	Likely	Significant	HIGH	Very Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	CONSTRUCTION RISKS								
CON-1	Post-Levee Removal Flooding	Following levee removal work on filling ag ditches will occur. The site will be vulnerable to flooding at that point and there could be slow downs.	This is likely to occur due to the duration required to remove the existing levee and fill the ditches. Likely to affect schedule only	Very Unlikely	Negligible	LOW	Likely	Significant	HIGH

CON-2	Earthwork - Settlement issues	Potential settlement issues and potential additional lifts to be added for levee construction.	Would like need to so stage construction where levees are constructed and then wait a year for settlement and then return to complete the work. Assume likely with significant impacts.	Likely	Significant	HIGH	Likely	Significant	HIGH
CON-3	Pump Station - site access	This item has the potential for complex construction issues.	Site access, demolition, and installation may present needs for unique cosntruciton techniques. Assume likely with significant impact.	Likely	Significant	HIGH	Unlikely	Significant	MODERATE
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	ESTIMATE AND SCHEDULE RISKS								
EST-1	Earthwork Quantities	Very few cross sections, just typical sections used in quantity development. Additionally the level of detail from LIDAR work is limited.	More information will be obtained as design progresses. It is likely that there will be a change in the quantities. Assume Significant impact. Large cost item.	Likely	Significant	HIGH	Likely	Significant	HIGH
EST-2	Pump station - Quantities	No information is known for the demolition or installation of the pump station.	Quantities developed were very rough estimates. Very likely for the quantities to change. Impact is large, assume critical.	Very Likely	Critical	HIGH	Very Likely	Significant	HIGH
EST-4	Landfill & Creosote Facility Quantities	Assumed depth of removal and percentage of area needing removal.	No basis for cost engineer's assumptions. Very Likely the quantities will change. Impact could double costs and are critical. ---JUNE 2014--- Risk is removed. HTRW issues are a 100% local sponsor responsibility. LERRD crediting is not applicable	Very Likely	Critical	HIGH	Very Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	ECONOMICS RISKS								
FL-1	Fuel	Fuel prices are volatile and will probably go up	A 25% increase in fuel could contribute to up to a 3% increase in total construction costs. How likely is it that gasoline will reach $5.00/gal? Depends on who you ask. For the purposes of this risk analysis, assume that it is unlikely.	Unlikely	Marginal	LOW	Very Unlikely	Negligible	LOW
FL-2	Asphalt	Asphalt is a petroleum product and subject to fluctuation.	Assume likely and marginal.	Likely	Marginal	MODERATE	Very Unlikely	Negligible	LOW
FL-3	Concrete & Steel		Cost of steel and other metals are subject to market conditions. It is believed that there is at least a 50% chance of fluctuation upward. The impact is considered to increase the total project costs no more than 1%	Likely	Marginal	MODERATE	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	Programmatic Risks	(External Risk items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)							
PR-1	Changing Laws/Regulations	Laws, regulations, and guidelines could change over the life of the project, potentially requiring changes in materials used on sites, adjusted construction methodology, or increased design/study requirements.	In general this risk was viewed to be very unlikely to affect the project. The only exception is that the WA Dept of Ecology may change its sediment management guidelines. However, these changes are not expected to require more than extremely minor adjustments to TPC.	Very Unlikely	Negligible	LOW	Very Likely	Negligible	LOW


PWMP
Telegraph Slough
Construction Schedule
ID
Task Mode
Task Name
Duration
Start
Finish
Aug 28, '16
May 28, '16
Feb 12, '17
Mar 2, '17
Jul 30, '17
Oct 22, '17
Jan 14, '18
Apr 8, '18
Jul 1, '18
Sep 23, '18
Dec 16, '18
Mar 10, '19
1 Telegraph Slough Full Restoration 625 days Mon 10/3/16 Thu 2/28/19
2 Start 1 day Mon 10/3/16 Mon 10/3/16
3 Demo Marina & Piers 27 days Tue 10/4/16 Wed 11/9/16
4 Construct (2) 6'x6' Box Culverts 19 days Tue 10/4/16 Fri 10/28/16
5 Construct Railroad Embankment 136 days Tue 10/4/16 Tue 3/14/17
6 Excavate Sediment Filled Channel 18 days Tue 10/4/16 Thu 10/27/16
7 Construct Temporary Traffic Controls 57 days Tue 10/4/16 Wed 12/21/16
8 Relocate Overhead Transmission 33 days Tue 10/4/16 Thu 11/17/16
9 Demo Site Wide Structures 68 days Tue 10/4/16 Thu 1/5/17
10 Demo Site Utilities/Septic 90 days Fri 11/18/16 Thu 3/23/17
11 Construct Setback Dike 63 days Fri 10/28/16 Tue 1/24/17
12 Construct New Railroad 90 days Wed 3/15/17 Tue 7/18/17
13 Construct Railroad Bridge 202 days Fri 10/28/16 Mon 8/7/17
14 Excavate Channel 6 days Wed 1/25/17 Wed 2/1/17
15 Demo Existing Railroad 29 days Wed 7/19/17 Mon 8/28/17
16 Construct West Bound SR 20 Bridge 248 days Fri 10/28/16 Tue 10/10/17
17 Construct 10' Culvert 19 days Thu 2/2/17 Tue 2/28/17
18 Lower Existing Utilities 68 days Wed 3/1/17 Fri 6/2/17
19 Raise SR 20 West Bound 112 days Wed 3/1/17 Thu 8/3/17
20 Raise SR 20 East Bound 112 days Wed 10/11/17 Thu 3/15/18
21 Construct East Bound SR 20 Bridge 248 days Wed 10/11/17 Fri 9/21/18
22 Remove Existing Dikes 114 days Mon 9/24/18 Thu 2/28/19
23 Remove Tidal Gates 15 days Mon 9/24/18 Fri 10/12/18
24 Finish 0 days Thu 2/28/19 Thu 2/28/19
2/28
Project: Telegraph Slough
Date: Fri 3/2/18
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Page 1

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
	PROJECT & PROGRAM MGMT								
PPM-1	Potential for scope reduction	As this project is a very large and diverse environmental restoration effort with multiple features there is the potential that project elements will be descoped to move forward with the project.	This is a tier 2 project encompassing a large array of features. This project is also one of the higher estimated projects and it is very likely that features will be descoped. Which specific features is unknown at this time.	Likely	Significant	HIGH	Likely	Significant	HIGH
PPM-2	Long delay before anticipated award date	This project award date has been set to 2034 as of July 2014. This is an extreme amount of time from project inception to award.	Contract costs could increase substantially if this project is not awarded until 2034. However, authorized funding is adjusted for inflation, and the impacts due to delay are mitigated somewhat because of this.	Very Likely	Significant	HIGH	Very Unlikely	Negligible	LOW
PPM-3	Authorization at 10% Design	Project is going forward for authorization at a 10% design level. Usually TSP is done at the 35%. Unknown elements may increase cost and schedule.	This impact was discussed while deciding to go down this path. This action is fairly well defined as is, and the potential for scope increases are accounted for in the evaluations of individual elements. This risk is to capture the potential for scope creep and added features that were not originally considered.	Unlikely	Significant	MODERATE	Unlikely	Negligible	LOW
PPM-4	Project Scheduling	High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.	PDT does not believe the volume of project will cause problems. Project will be schedule over years and even decades in order to meet construction goals.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-5	Staffing Reductions	Both the Seattle District and the WDFW have numerous projects competing for staffing resources. If other projects become a higher priority staff could be pulled from PSNERP.	PSNERP remains a District and WDFW priority and will is less likely than other projects to see staffing reductions. There are minor cost increases due to increases in work being out-sourced to AEs and potential slowdowns is staffing is shifted on short notice.	Very Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-6	Communication Issues	Excellent communications is necessary in order to successfully complete the project. Both internal issues intra-Corps or intra-WDFW, or issues between the Corps and local sponsors could affect the project timeline.	The project currently has strong communication and trust between the Corps and WDFW, and enjoys high levels of political support both from the Federal and local sponsors. There are other local sponsors (municipalities, tribes, NGOs, etc.) that will be involved once the project moves into PED/CG phase. This is not expected to be a cost risk.	Very Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-7	Poor Initial Project Performance	The PSNERP project will be very visible in the Puget Sound area once construction begins. Could an early action that performs poorly (reduced environmental benefits, project neighbors who felt slighted or whose concerns were not fully addressed, etc.) cause the remainder of the project to have increased cost/schedule?	PDT believes its very unlikely that there would be a poorly performing initial project as the earliest projects that proceed to construction are likely to be those whose success is the most assured. Impacts would likely be delays to the start of projects, and costs other than increases due to inflation would be unlikely.	Very Unlikely	Marginal	LOW	Very Unlikely	Negligible	LOW
PPM-8	Multi-year contract award	This project has an extremely large estimate construction cost. There is a risk that the project will be broken into multiple contract phases and awarded separately over multiple Fiscal Years	PDT believes its like that this project will be broken up into smaller contract solicitations due to the large estimated construction cost. It is unknown how the project would be broken up at this time, and what the cost impacts of this would be.	Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	CONTRACT ACQUISITION RISKS								

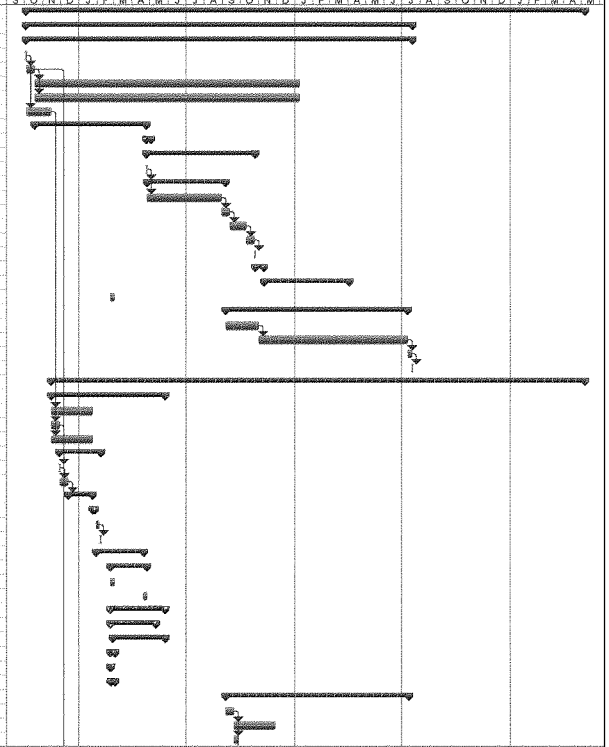
CA-1	Acquisition strategy has not been determined	Acquisition strategy is currently not defined. This estimate assumes full and open acquisition. For this level of estimate, with so much uncertainty, all work has been assumed to be subcontracted out.	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went out to a large well equipped contractor the costs could be reduced by less subcontracting. Subbing out 20% of the work results in approximately a 5% reduction in total cost.	Unlikely	Marginal	LOW	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	TECHNICAL RISKS								
TL-1	Temporary Traffic Crossovers	Unknowns in how the traffic will be managed during demolition of the existing bridge and construction of new bridge.	Without preliminary design there is potential for scope change regarding traffic management	Likely	Marginal	MODERATE	Unlikely	Negligible	LOW
TL-2	Plans are incomplete	Drawings that are available are conceptual in nature and may contain errors or not fully match the site	Very likely that there is some level of data missing from the current design reports and plans. This risk to capture the potential for cost driving errors in construction features that were identified but limited data was available and assumptions were used; such as bridge piles, bridge profile, utility locations and types.	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	LANDS AND DAMAGES RISKS								
LD-1	Demolition of Misc. Buildings (Marina Boat Storage Facility)	The Marina has not been contacted about any restoration actions affecting their property.	The Marina would need to be acquired because of the modification to the berms. If it is not acquired, there would be a change to the project features (dike alignment), but the project could continue.	Very Likely	Significant	HIGH	Very Likely	Significant	HIGH
LD-2	Railroad Right-of-Entry	Right of entry will be required at all sites with rail roads. Could negotiations with the rail roads extend project timelines?	It's very unlikely to affect an individual project schedule since all real estate items must be negotiated prior to construction beginning. However, it's possible that the right of entry negotiations could contain restrictions as to how work is conducted at the site (e.g., rail operations must be allowed to continue uninterrupted), and these may affect project cost.	Very Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	REGULATORY AND ENVIRONMENTAL RISKS								
RE-1	Cultural Resource Preservation	Discovery of an archaeological site of significance.	While there has been no previous surveys done within the project APE, there is a known archaeological site within a half mile radius of the project area. The entire APE will need to be surveyed, and if any archaeological resources are found, they will need to be tested and evaluated for the NRHP.	Likely	Marginal	MODERATE	Likely	Significant	HIGH

RE-2	Building Demolition HTRW	Presence of contaminants at the building sites	Soils and sediments may be contaminated with petroleum hydrocarbons, heavy metals, creosote timbers, and paint containing TBT. Recommend Level I and II surveys be conducted to document extent of contamination. Dredged material may need to be hauled to an appropriate dump site depending on contamination chemical concentrations. Parcels may have stored petroleum products and pesticides, lead-based paint, and asbestos. Recommend Level I and II surveys to document presence/absence of contaminants. (JULY 2014: Risk is removed. HTRW issues are a 100% local sponsor responsibility. LERRD crediting is not applicable)	Very Likely	Marginal	MODERATE	Very Likely	Significant	HIGH
RE-3	Earthwork contamination HTRW	Presence of contaminants for the major earthwork excavations.	Sediments may contain debris and contamination. Recommend Level II survey be conducted to determine presence/absence of contamination. If contamination is documented, dredged material may need to be hauled to an appropriate dump site. Reuse of dike materials may contain contaminated soils since original soil origin unknown. Soil may contain petroleum hydrocarbons. (July 2014: Risk is removed. HTRW issues are a 100% local sponsor responsibility. LERRD crediting is not applicable)	Likely	Significant	HIGH	Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	CONSTRUCTION RISKS								
CON-1	No project grading details for earthwork	Preliminary planning stages, insufficient LiDar data and no grading details known for the extensive earthwork outlined for this project.	There could be additional requirements imposed in the excavation and fill. It is thought to be at least a 50% chance that the scope of the earthwork will change.	Likely	Crisis	HIGH	Likely	Critical	HIGH
CON-2	Site Access Issues	There is the potential that excavators will not be sufficient for some excavation work and barging will be need. Also the possible requirement for access haul roads for excavators.	If marine dredging and barge access is required there could be a significant cost increase compared to hydraulic excavation. If excavation is used, there is still the chance that additional haul roads may be needed	Likely	Significant	HIGH	Likely	Marginal	MODERATE
CON-3	Unknown Marina Site conditions	Potential for constructability issues with this site due to lack of information about the existing conditions	Without further information the scope of this work is unknown at this time and could differ from the assumptions initially made.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
CON-4	Embankment Settlement	settle	the proposed levee will need to settle in order to bring it up	Likely	Critical	HIGH	Likely	Significant	HIGH
CON-5	Berm Settlement	Possibility that the new rail berm will settle	Without geotechnical information, it is unknown whether the proposed berm will need to settle in order to bring it up to full elevation. The berm is extensive so it is assume that additional settlement will be localized occurrences only	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
CON-6	Equipment access	Site conditions were assumed appropriate to bring in large equipment. Changes in this would affect size of equipment and thus production.	If weather and soil conditions are not suitable for large equipment, smaller pieces will need to be brought in. A 20% slowdown in production will increase levee removal and install costs. This would have a critical impact on overall cost.	Likely	Crisis	HIGH	Likely	Crisis	HIGH
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	ESTIMATE AND SCHEDULE RISKS								
EST-1	No recycled construction waste estimated	Opportunity for recycling construction waste from earthwork and pavement demolition at a reduced cost	Potential for cost savings	Unlikely	Significant	MODERATE	Very Unlikely	Negligible	LOW

EST-2	Utility scope assumptions	This item is for overhead electric, over head communication, underground petroleum and underground water pipelines. Preliminary planning stage. Very little information provided. Many assumptions made.	There is a very likely chance that the scope of this work will change. There could be requirements to this work by the utility owners. There may be additional upgrades to the system needed. There could be additional utilities not identified and in other areas of the project.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
EST-3	Bridge Design Assumptions	No designs were produced at this level of design. Typical section used for the estimate.	The bridge time is likely to change or some elements of the scope of the prosed bridges. The bridges are approximately 20% of the TPC.	Likely	Significant	HIGH	Likely	Critical	HIGH
EST-4	Fuel Cost increasing	Large equipment makes fuel cost increase a potential cost concern	Fuel costs for the machinery and the hauling. An increase of 25% in fuel costs increases the total project cost by approximately 2%	Unlikely	Significant	MODERATE	Very Unlikely	Negligible	LOW
EST-5	Steel cost increasing	amounts of steel.	conditions. It is believed that there is at least a 50%	Likely	Significant	HIGH	Very Unlikely	Negligible	LOW
EST-6	Market considerations	A competitive market may not occur at the time the project is out for bid. If this occurs, project costs may rise.	Estimate was created assuming small business bidding with relatively high contractor markups, and limited self-performed work. It is unlikely that even in a very robust market that prices would rise substantially beyond this.	Very Unlikely	Critical	LOW	Very Unlikely	Negligible	LOW
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
Programmatic Risks (External Risk items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)									
PR-1	Political considerations	Federal, state, and local priorities may shift changing project priorities.	Opposition to the project is not expected, since this does not impact property owners and is considered to add benefits to the area. If political considerations due come into play, the project may be cancelled outright, but it is unlikely to play a role in cost or schedule.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
PR-2	Changing Laws/Regulations	Laws, regulations, and guidelines could change over the life of the project, potentially requiring changes in materials used on sites, adjusted construction methodology, or increased design/study requirements.	In general this risk was viewed to be very unlikely to affect the project. The only exception is that the WA Dept. of Ecology may change its sediment management guidelines. However, these changes are not expected to require more than extremely minor adjustments to TPC.	Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW

PSNERP
Chambers Bay Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Chambers Bay Full Alt**	**676 days**	**Mon 10/3/16**	**Mon 5/6/19**	
2	**[06] Fish and Wildlife Facilities**	**468 days**	**Mon 10/3/16**	**Wed 7/18/18**	
3	**[06 03] Wildlife Facilities and Sanctuaries**	**468 days**	**Mon 10/3/16**	**Wed 7/18/18**	
4	Mobilization	1 day	Mon 10/3/16	Mon 10/3/16	
5	Survey	10 days	Tue 10/4/16	Mon 10/17/16	4
6	Traffic Control Flaggers	320 days	Tue 10/18/16	Mon 1/8/18	5
7	Street Cleaning	320 days	Tue 10/18/16	Mon 1/8/18	5
8	Silt Fence	30 days	Tue 10/4/16	Mon 11/14/16	4
9	**Excavation**	**135 days**	**Tue 10/18/16**	**Mon 4/24/17**	
16	**Fill**	**6 days**	**Tue 4/25/17**	**Tue 5/2/17**	
17	**Demolition**	**132 days**	**Tue 4/25/17**	**Wed 10/25/17**	
18	Mobilization	1 day	Tue 4/25/17	Tue 4/25/17	14
19	**Dam**	**95 days**	**Wed 4/26/17**	**Tue 9/5/17**	18
22	Buildings	90 days	Wed 4/26/17	Tue 8/29/17	18
23	Bulkhead	10 days	Wed 8/30/17	Tue 9/12/17	22
24	Marina	20 days	Wed 9/13/17	Tue 10/10/17	23
25	Misc Pile Removal	10 days	Wed 10/11/17	Tue 10/24/17	24
26	Demobilization	1 day	Wed 10/25/17	Wed 10/25/17	25
27	**Dredging and Placement**	**11 days**	**Thu 10/26/17**	**Thu 11/9/17**	
31	**Vegetation**	**102 days**	**Fri 11/10/17**	**Mon 4/2/18**	
36	Utilities	5 days	Thu 2/23/17	Wed 3/1/17	61
37	**Fish Hatchery**	**220 days**	**Wed 9/6/17**	**Tue 7/10/18**	
38	Demolition	2 mons	Wed 9/6/17	Tue 10/31/17	21
39	Installation	9 mons	Wed 11/1/17	Tue 7/10/18	38
40	Post Construction Survey	5 days	Wed 7/11/18	Tue 7/17/18	39
41	Demobilization	1 day	Wed 7/18/18	Wed 7/18/18	40
42	**[06] Roads, Railroads, and Bridges**	**645 days**	**Tue 11/15/16**	**Mon 5/6/19**	
43	**[09 01] Roads**	**139 days**	**Tue 11/15/16**	**Fri 5/26/17**	
44	Traffic Control	50 days	Tue 11/15/16	Mon 1/23/17	8
45	Silt Fence	10 days	Tue 11/15/16	Mon 11/28/16	8
46	Street Cleaning	50 days	Tue 11/15/16	Mon 1/23/17	8
47	**Earthwork**	**50 days**	**Tue 11/29/16**	**Mon 2/6/17**	
48	Mobilization	1 day	Tue 11/29/16	Tue 11/29/16	45
49	Pre Construction Survey	10 days	Wed 11/30/16	Tue 12/13/16	48
50	**Excavation**	**29 days**	**Wed 12/14/16**	**Mon 1/23/17**	49
53	**Fill**	**4 days**	**Tue 1/24/17**	**Fri 1/27/17**	
55	Post Construction Survey	5 days	Mon 1/30/17	Fri 2/3/17	54
56	Demobilization	1 day	Mon 2/6/17	Mon 2/6/17	55
57	**Pavement**	**59 days**	**Mon 1/30/17**	**Thu 4/20/17**	
66	**Guard Rail**	**44 days**	**Thu 2/23/17**	**Tue 4/25/17**	
67	Demolition	5 days	Thu 2/23/17	Wed 3/1/17	61
68	Installation	4 days	Thu 4/20/17	Tue 4/25/17	64
69	**Utilities**	**67 days**	**Thu 2/23/17**	**Fri 5/26/17**	
70	**Demolition**	**55 days**	**Thu 2/23/17**	**Wed 5/10/17**	
79	**Installation**	**65 days**	**Mon 2/27/17**	**Fri 5/26/17**	
87	**Drainage**	**6 days**	**Thu 2/23/17**	**Thu 3/2/17**	
88	**Demolition**	**1 day**	**Thu 2/23/17**	**Thu 2/23/17**	
91	**Installation**	**5 days**	**Fri 2/24/17**	**Thu 3/2/17**	
93	**Bridge**	**222 days**	**Wed 9/6/17**	**Thu 7/12/18**	
94	Preconstruction Survey	10 days	Wed 9/6/17	Tue 9/19/17	21
95	Traffic Control	50 days	Wed 9/20/17	Tue 11/28/17	94
96	Silt Fence	5 days	Wed 9/20/17	Tue 9/26/17	94

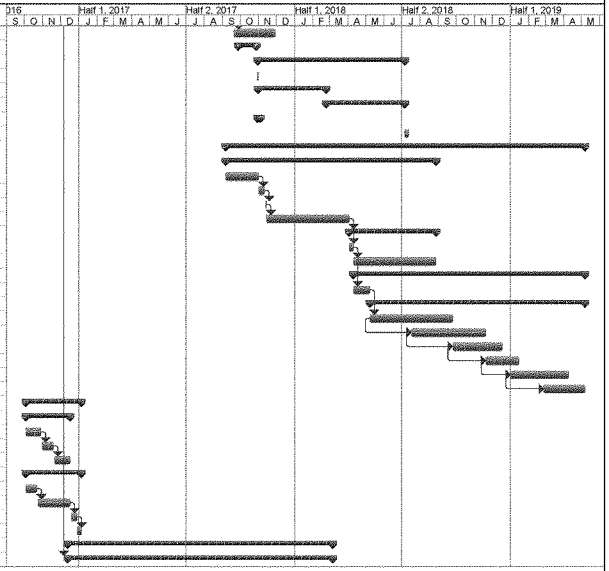


Project: Chambers Bay Estuary
Date: Fri 3/25/16

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Progress
Split	External Tasks	Inactive Summary	Manual Summary	Deadline
Milestone	External Milestone	Manual Task	Start-only
Summary	Inactive Task	Duration-only	Finish-only

PSNERP
Chambers Bay Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
97	Street Clearing	50 days	Wed 9/20/17	Tue 11/28/17	94
98	**Demolition**	**23 days**	**Wed 9/27/17**	**Fri 10/27/17**	
106	**Placement**	**179 days**	**Mon 10/30/17**	**Thu 7/5/18**	
107	Mobilization	1 day	Mon 10/30/17	Mon 10/30/17	105
108	**New Bridge North**	**83 days**	**Tue 10/31/17**	**Thu 2/22/18**	
122	**New Bridge South**	**95 days**	**Fri 2/23/18**	**Thu 7/5/18**	
136	**Utilities**	**5 days**	**Mon 10/30/17**	**Fri 11/3/17**	
142	Post Construction Survey	5 days	Fri 7/6/18	Thu 7/12/18	135
143	**Railroads**	**434 days**	**Wed 9/6/17**	**Mon 5/6/19**	
144	**Demolition**	**254 days**	**Wed 9/6/17**	**Mon 8/27/18**	
145	Cut & Prep Concrete Counterweights	40 days	Wed 9/6/17	Tue 10/31/17	21
146	Pick & Remove Concrete Counterweight Sections [Sea]	8 days	Wed 11/1/17	Fri 11/10/17	145
147	Rail Removal	1 day	Mon 11/13/17	Mon 11/13/17	146
148	Railroad Bridge Demolition [steel truss]	100 days	Tue 11/14/17	Mon 4/2/18	147
149	**Concrete Piers - Demolition**	**105 days**	**Tue 4/3/18**	**Mon 8/27/18**	**148**
150	Cofferdam Installation	5 days	Tue 4/3/18	Mon 4/9/18	148
151	Concrete Pier Demolition	100 days	Tue 4/10/18	Mon 8/27/18	150
152	**Installation**	**280 days**	**Tue 4/10/18**	**Mon 5/6/19**	
153	Rail Transition	20 days	Tue 4/10/18	Mon 5/7/18	150
154	**New Trestle Railroad Bridge**	**260 days**	**Tue 5/8/18**	**Mon 5/6/19**	
155	Drilled Cassion Composite Pile Assembly (Shafts)	100 days	Tue 5/8/18	Mon 9/24/18	153
156	Composite Pile Assembly - Upper	90 days	Tue 7/17/18	Mon 11/19/18	155SS+50 days
157	Pile Caps	60 days	Tue 9/25/18	Mon 12/17/18	156SS+50 days
158	Bridge Beams	40 days	Tue 11/20/18	Mon 1/14/19	157SS+40 days
159	Deck	70 days	Tue 1/1/19	Mon 4/8/19	158SS+30 days
160	Parapet Wall Steel Rail	50 days	Tue 2/26/19	Mon 5/6/19	159SS+40 days
161	**[18] Cultural Resource Preservation**	**69 days**	**Mon 10/3/16**	**Wed 1/4/17**	
162	**[18 00] Cultural Resource Preservation**	**55 days**	**Mon 10/3/16**	**Fri 12/16/16**	
163	Cultural Resource Survey	20 days	Mon 10/3/16	Fri 10/28/16	
164	Cultural Resource Report and Consultation	15 days	Mon 10/31/16	Fri 11/18/16	163
165	Potential NRHP Evaluation	20 days	Mon 11/21/16	Fri 12/16/16	164
166	**Built Environment**	**69 days**	**Mon 10/3/16**	**Wed 1/4/17**	
167	Inventory	15 days	Mon 10/3/16	Fri 10/21/16	
168	Site from and report preparation	40 days	Mon 10/24/16	Fri 12/16/16	167
169	Determination of effects	8 days	Mon 12/19/16	Wed 12/28/16	168
170	Consultation	5 days	Thu 12/29/16	Wed 1/4/17	169
171	**[32] HTRW**	**320 days**	**Tue 12/13/16**	**Mon 3/5/18**	
172	**Treat-Wastes/Contaminated Soil & Water**	**320 days**	**Tue 12/13/16**	**Mon 3/5/18**	5



Project: Chambers Bay Estuary
Date: Fri 3/25/16

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Progress
Split	External Tasks	Inactive Summary	Manual Summary	Deadline
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

Chambers Bay Estuarine and Riparian Enhancement

Preliminary Budget Estimate Level
Abbreviated Risk Analysis

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	06 Earthwork	This item includes excavation of abutment fill southwest of the dam, excavation of fill associated with the mill site, rock armoring along Chambers Creek Road, excavation of the marina, and excavation of the peninsula northeast of the marina. Preliminary planning stages and no grading details known.	Very few cross sections for excavation. No details of area, just large scale aerial views. There is the possibility that the areas of excavation and fill could change from what is presented in the draft report. Any increase in quantity will be covered in the Quantity risk element section. The risk here is that the nature of the earthwork may change. There could be additional requirements (not quantities) imposed in the excavation and fill. It is thought to be at least a 50% chance that the scope of the earthwork will change. Changes to the current perceived scope are definitely expected to increase TPC by at least 1%.	Very LIKELY	Significant	4
PS-2	Demolition	This item is for the demolition and disposal of the dam, buildings, bulkhead, marina, and miscellaneous pile removal. No details for this work. No as-builts.	No details of area, just large scale aerial views. See PS-1 for description of quantities. The risk here is that not all of the scope is captured; there is a very likely chance that more work/tasks are needed to perform this demolition. Changes to the current perceived scope are definitely expected to increase TPC by at least 1%.	Very LIKELY	Significant	4
PS-3	Fish Hatchery	No information. No scope for this work.	Very likely scope will change since there is currently no scope. See PS-1 for discussion of quantities. Assume critical impact.	Very LIKELY	Critical	5
PS-4	Vegetation	This item is for the planting of riparian and marsh/wetland areas at the Deschutes Parkway where dredged material will be placed. There is no specific information in the report regarding this work aside from where and the quantity of surface area.	See PS-1 for a description of the quantities. The risk here is that not all of the scope is captured; there is a very likely chance that more work/tasks are needed to perform this work These could include soil treatment, guaranteed growth clauses, etc. Changes to the current perceived scope are definitely expected to increase TPC by at least 1%.	Very LIKELY	Significant	4
PS-5	08 Pavement	Preliminary stage of project planning. Assumed landfill disposal. There could be a potential opportunity in recycling the asphalt for a reduced disposal fee.	This risk analysis does no account for opportunities (cost savings). However it should be noted in the Risk Register. There are risks in the quantities, but that will be covered in the Quantity risk element. No other concerns with this item.	Unlikely	Negligible	0
PS-6	08 Utilities	Preliminary planning stage. Very little information provided. Many assumptions made.	There is a very likely chance that the scope of this work will change. There could be requirements to this work by the utility owners. There may be additional upgrades to the system needed. There could be additional utilities not identified and in other areas of the project. See PS-1 for a description of Utilities the quantities. The impact could add more than 1% to the TPC.	Very LIKELY	Significant	4
PS-7	Bridge Placement - North & South Bridge	Preliminary planning stage. No typical section. Very little information provided Many assumptions made.	Assume that the governing agency will accept what is proposed. The bridge type is likely to change or some elements of the scope of the proposed bridge. The bridge is approximately 10% of the construction cost.	LIKELY	Significant	4
PS-8	Remove Draw Bridge	No details for this work. No as-builts.	No details of area, just large scale aerial views. See PS-1 for description of quantities. The risk here is that not all of the scope is captured; there is a very likely chance that more work/tasks are needed to perform this demolition. Changes to the current perceived scope are definitely expected to increase TPC by at least 1%.	Very LIKELY	Significant	4
PS-9	New Trestle Railroad Bridge	See PS-7	The bridge is approximately 30% of the TPC.	Very LIKELY	Critical	5

PS-10	Cultural Resources Preservation	Per Ashley Dailide, NWS lead Archeologist: "There is a high potential for this project to impact archaeological resources within the project area." Per Mary McCormick, NWS: "The Chambers Bay project's APE has a comparatively well developed built environment, dominated by industrial- and transportation-related properties."	"There are four archaeological sites within the project APE that will need to be tested and evaluated for the NRHP. If these sites are found to be eligible, they must be avoided or mitigated prior to project construction. Furthermore, any uninvestigated portions of the APE must be surveyed and any further archaeological resources that may be found must also be evaluated." "Inventory work at Chambers Bay is expected to fully record and evaluate all of the properties listed above (in another document), including the BNSF causeway. The causeway bridge will still need to be inspected to determine if it has sustained modifications since listing in the National Register. Extant buildings and structures (if any) at the 1920s paper mill will need to be recorded and evaluated, and/or the locale investigated for its archaeological values. Otherwise, no more than three additional historic-age properties are presumed to exist in the APE. State and local historic preservation entities likely will have considerable concerns about adverse impacts to the railroad bridge and other properties determined eligible for listing, resulting in a lengthy consultation process. The risk that that avoidance and/or mitigations costs will incur on this project is high."	LIKELY	Critical	5
PS-11	HTRW Fill Associated with Mill Site	Preliminary planning stage. See PS-1.	Likely there will be scope change. Impact is assumed Significant.	LIKELY	Significant	4
PS-12	Remaining Construction Items	This is busy proposed site with many different elements of work. Given the number of tasks and location of the work, there were not many details provided and the project could be approached in manner different manners based upon the current level of project development. There are many unknowns and additional tasks involved in the project that could be captured in this risk area.	It is very likely that the items covered in this risk area could have a change in scope and definitely that scope would be added. The impact could exceed 1% of the TPC.	Very LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Acquisition Strategy						
AS-1	06 Earthwork	This estimate assumes full and open acquisition. However, the prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from IFB full competition. The size of this project is very large. The project will probably be constructed under multiple acquisitions.	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. Given the nature of this work it is felt that it could go small business. Also, other methods may be used as well. It is considered likely that the contracting method could change from what is proposed in the estimate. The impact could be over 5%.	Very LIKELY	Critical	5
AS-2	Demolition	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-3	Fish Hatchery	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-4	Vegetation	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-5	08 Pavement	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-6	08 Utilities	See AS-1. Possibility of utility owners performing the work which could be a cost increase.	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-7	Bridge Placement - North & South Bridge	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-8	Remove Draw Bridge	See AS-1. Possibility of railroad owners performing the work which could be a cost increase.		Very LIKELY	Critical	5
AS-9	New Trestle Railroad Bridge	See AS-1. Possibility of railroad owners performing the work which could be a cost increase.		Very LIKELY	Critical	5
AS-10	Cultural Resources Preservation	Not applicable		Very Unlikely	Negligible	0
AS-11	HTRW Fill Associated with Mill Site	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
AS-12	Remaining Construction Items	See AS-1	Lesser impact given item percentage to TPC.	Very LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Construction Complexity						
CC-1	06 Earthwork	No significant concerns. General location could pose some challenges.	Assume unlikely and marginal impact.	Unlikely	Marginal	1
CC-2	Demolition	Many unknowns.	There are always uncertainties with demolition of existing structures. Particularly in this case given the level of project	LIKELY	Significant	4
CC-3	Fish Hatchery	Many unknowns.	Assume unlikely and marginal impact.	Unlikely	Marginal	1
CC-4	Vegetation	No concerns.		Unlikely	Negligible	0
CC-5	08 Pavement	No concerns.		Unlikely	Negligible	0
CC-6	08 Utilities	No concerns.		Very Unlikely	Negligible	0
CC-7	Bridge Placement - North & South Bridge	No concerns. A competent bridge contractor should be able to perform this work.		Very Unlikely	Negligible	0
CC-8	Remove Draw Bridge	Large overhead structure with restricted access.	Unique demolition. Unknowns and methods required not fully vetted.	LIKELY	Significant	4
CC-9	New Trestle Railroad Bridge	See CC-1		Unlikely	Marginal	1
CC-10	Cultural Resources Preservation	No concerns.		Very Unlikely	Negligible	0
CC-11	HTRW Fill Associated with Mill Site	HTRW work can present some constructability issues.	There are currently unknowns since the requirements of this work has not been established. Assume likely and significant.	LIKELY	Significant	4
CC-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Volatile Commodities						
VC-1	06 Earthwork	Fuel prices.	A 25% increase in fuel could contribute to up to a 1.5% increase in total construction costs. How likely is it that gasoline will reach $5.00/gal? Depends on who you ask. For the purposes of this risk analysis, assume that it is unlikely. Impact is significant.	Unlikely	Significant	3
VC-2	Demolition	No concerns.		Unlikely	Negligible	0
VC-3	Fish Hatchery	Concrete, Steel.	Cost of steel and other metals are subject to market conditions. It is believed that there is at least a 50% chance of fluctuation upward. The impact is considered to increase the total project costs no more than 1%	LIKELY	Marginal	2
VC-4	Vegetation	No concerns.		Unlikely	Negligible	0
VC-5	08 Pavement	Asphalt	Asphalt is a petroleum product and subject to market conditions. Assume likely and negligible.	LIKELY	Negligible	1
VC-6	08 Utilities	See VC-6, Pipe costs.	Assume likely and negligible.	LIKELY	Negligible	1
VC-7	Bridge Placement - North & South Bridge	See VC-3		LIKELY	Marginal	2
VC-8	Remove Draw Bridge	No concerns.		Very Unlikely	Negligible	0
VC-9	New Trestle Railroad Bridge	See VC-3		LIKELY	Marginal	2
VC-10	Cultural Resources Preservation	No concerns.		Very Unlikely	Negligible	0
VC-11	HTRW Fill Associated with Mill Site	No concerns at this time.		Very Unlikely	Negligible	0
VC-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Quantities						
Q-1	06 Earthwork	Very few cross sections for fill, just typical sections used in quantity development. No cross sections for excavation.	No earthwork balance has been calculated or evaluated. More information will be obtained as design progresses. It is very likely that there will be a change in the quantities. Assume Critical impact. Large cost item.	Very LIKELY	Critical	5
Q-2	Demolition	No information. Quantities subject to change. Many assumptions made in developing quantities.	Likely that the quantities will significantly change. Impact could be at least a 1% increase to the TPC.	LIKELY	Significant	4
Q-3	Fish Hatchery	See PS-3	Likely that the quantities will significantly change. Impact could be at least a 1% increase to the TPC.	LIKELY	Significant	4

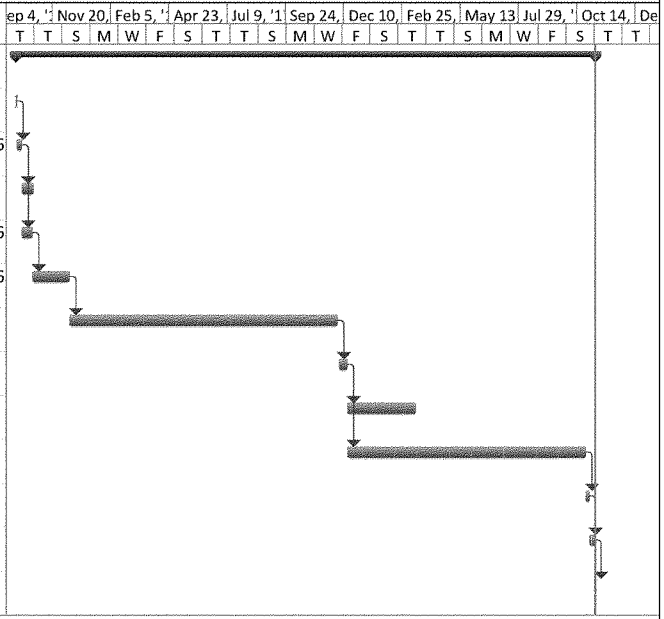
Q-4	Vegetation	Assumed a density and type of material to be placed.	This is very likely to change. The impact is unknown. Assume marginal.	Very LIKELY	Marginal	3
Q-5	08 Pavement	Assumed depth of removal. Asphalt placement design subject to change.	Likely to change. Impact is difficult to evaluate since disposal fees are the largest cost in demolition. Changes in asphalt placement could increase costs.	LIKELY	Marginal	2
Q-6	08 Utilities	See PS-6.	Size, material, and lengths estimated. There is a very likely potential that any or all of these three will change. New alignments with the bridge and roadway could cause the utility adjustments to extend beyond what is originally planned in the report. Impact could increase TPC by at least 1%.	Very LIKELY	Significant	4
Q-7	Bridge Placement - North & South Bridge	Used a typical section for the quantity development.	Conservative in the caisson depth. Many assumptions were made. It is likely that the quantities will change. The impact could easily be over 1%.	LIKELY	Significant	4
Q-8	Remove Draw Bridge	Many unknowns and assumptions made. See PS-8.	Very likely quantities will change. Assume critical impact.	Very LIKELY	Critical	5
Q-9	New Trestle Railroad Bridge	See Q-7.		LIKELY	Significant	4
Q-10	Cultural Resources Preservation	Time spent on study is an estimate.	Findings could lead to more time being required.	LIKELY	Negligible	1
Q-11	HTRW Fill Associated with Mill Site	See Q-1		Very LIKELY	Critical	5
Q-12	Remaining Construction Items	Preliminary information and no design.	Quantities were large in part just estimates. Most of the quantities in the Remaining Construction items were very roughly estimated. It is very likely that these quantities will increase. The impact could increase the TPC by 1%.	Very LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Fabrication & Project Installed Equipment						
FI-1	06 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
FI-2	Demolition	No concerns at this time.		Very Unlikely	Negligible	0
FI-3	Fish Hatchery	No design. Many unknowns.	Pumps, filters, electrical components, etc.	LIKELY	Significant	4
FI-4	Vegetation	No concerns.		Very Unlikely	Negligible	0
FI-5	08 Pavement	No concerns.		Very Unlikely	Negligible	0
FI-6	08 Utilities	No concerns at this time.		Very Unlikely	Negligible	0
FI-7	Bridge Placement - North & South Bridge	No concerns at this time.		Very Unlikely	Negligible	0
FI-8	Remove Draw Bridge	No concerns at this time.		Very Unlikely	Negligible	0
FI-9	New Trestle Railroad Bridge	No concerns at this time.		Very Unlikely	Negligible	0
FI-10	Cultural Resources Preservation	No applicable.		Very Unlikely	Negligible	0
FI-11	HTRW Fill Associated with Mill Site	No concerns at this time.		Very Unlikely	Negligible	0
FI-12	Remaining Construction Items	No concerns at this time.		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Cost Estimating Method						
CE-1	06 Earthwork	Lack of time to be able to spend on the estimate.	Unlikely there would be significant changes. Impacts assumed marginal.	Unlikely	Marginal	1
CE-2	Demolition	Many assumptions made. See CE-1.	Likely there will be changes to the methodology in the cost estimate. Impact assumed marginal.	LIKELY	Marginal	2
CE-3	Fish Hatchery	Used a previous cost estimate. See CE-1.	Validity may be in question. See CE-2.	LIKELY	Marginal	2
CE-4	Vegetation	No concerns at this time.		Very Unlikely	Negligible	0
CE-5	08 Pavement	No concerns at this time.		Very Unlikely	Negligible	0

CE-6	08 Utilities	Used many cost book items. Used many assumptions.	Cost book items and assumptions may not be entirely accurate or applicable to the project.	LIKELY	Marginal	2
CE-7	Bridge Placement - North & South Bridge	See CE-6	Greater impact.	LIKELY	Significant	4
CE-8	Remove Draw Bridge	See CE-7		LIKELY	Significant	4
CE-9	New Trestle Railroad Bridge	See CE-7		LIKELY	Critical	5
CE-10	Cultural Resources Preservation	Made assumptions.	Assumptions may not be valid.	LIKELY	Negligible	1
CE-11	HTRW Fill Associated with Mill Site	No concerns for items covered in the estimate. Concern is for items not covered in the estimate. That concern is covered in the scope risk element		Very Unlikely	Negligible	0
CE-12	Remaining Construction Items	Concerns covered in other risk elements.		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
External Project Risks						
EX-1	06 Earthwork	Land ownership. Water rights. Stakeholder support.	The mill site is currently for sale. Willingness of other property owners is in question. It is likely that there will be affects to the project from the noted concerns. It is a safe assumption that the impact is critical.	LIKELY	Critical	5
EX-2	Demolition	See EX-1	Lesser impact given item percentage to TPC.	LIKELY	Significant	4
EX-3	Fish Hatchery	See EX-1	Lesser impact given item percentage to TPC.	LIKELY	Significant	4
EX-4	Vegetation	No concerns.		Very Unlikely	Negligible	0
EX-5	08 Pavement	No concerns at this time.		Very Unlikely	Negligible	0
EX-6	08 Utilities	Stakeholders.	See EX-1. Working with utility owners. Likely there will be an impact to the project. Impact assumed marginal.	LIKELY	Marginal	2
EX-7	Bridge Placement - North & South Bridge	See EX-2		LIKELY	Significant	4
EX-8	Remove Draw Bridge	Working with the railroad company.	It is likely that there will be affects to the project from the noted concerns. It is a safe assumption that the impact is significant.	LIKELY	Significant	4
EX-9	New Trestle Railroad Bridge	See EX-8		LIKELY	Significant	4
EX-10	Cultural Resources Preservation	No concerns at this time.		Very Unlikely	Negligible	0
EX-11	HTRW Fill Associated with Mill Site	No concerns at this time.		Very Unlikely	Negligible	0
EX-12	Remaining Construction Items	See EX-1	Lesser impact given item percentage to TPC.	LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
HTRW						
HTRW-1	06 Earthwork	Per John Kill Eagle on 6/21/2011 : Quantities of potentially contaminated sediment behind dam could very significantly from the estimated total sediment of 7,300 CY.	The Level I report estimates 50% to be contaminated. A more conservative estimate of 100% should be used to estimate the contaminated sediment that must be disposed of in landfill.	LIKELY	Marginal	2
HTRW-2	Demolition	Per John Kill Eagle on 6/21/2011 : 7,300 square feet of buildings at dam abutments (fish hatchery, support building, and water intake building) and 46,700 square feet of buildings at the marina are likely to have hazardous waste associated with demolition. Surveys of LBP and asbestos building material should be conducted to determine the presents of this hazardous waste that must be disposed of at a licensed landfill.	Hazardous waste can be estimated through percentage of square feet of building spa	Very Unlikely	Significant	1
HTRW-3	Fish Hatchery	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-4	Vegetation	No concerns.		Unlikely	Negligible	0
HTRW-5	08 Pavement	No concerns.		Very Unlikely	Negligible	0
HTRW-6	08 Utilities	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-7	Bridge Placement - North & South Bridge	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-8	Remove Draw Bridge	Material could have contaminates associated with it (lead paint, etc.)	Assume likely due to the age of the bridge with marginal impacts.	LIKELY	Marginal	2

HTRW-9	New Trestle Railroad Bridge	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-10	Cultural Resources Preservation	Not applicable		Very Unlikely	Negligible	0
HTRW-11	HTRW Fill Associated with Mill Site	Concerns covered by in other risk elements since this is a project item.		Very Unlikely	Negligible	0
HTRW-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0
HTRW-13	Planning, Engineering, & Design			Very Unlikely	Negligible	0
HTRW-14	Construction Management			Very Unlikely	Negligible	0

PSNERP
Big Beef Creek Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish
1	**Big Beef Causeway**	**548 days**	**Mon 10/3/16**	**Wed 11/7/18**
2	Start	1 day	Mon 10/3/16	Mon 10/3/16
3	Mobilize	5 days	Tue 10/4/16	Mon 10/10/16
4	Road Approach Fill	11 days	Tue 10/11/16	Tue 10/25/16
5	Pier Demo	10 days	Tue 10/11/16	Mon 10/24/16
6	Finger Pier Construction	35 days	Tue 10/25/16	Mon 12/12/16
7	Bridge Construction	254 days	Tue 12/13/16	Fri 12/1/17
8	Relocate Utilities	9 days	Mon 12/4/17	Thu 12/14/17
9	Remove Causeway	64 days	Fri 12/15/17	Wed 3/14/18
10	Demo Existing Bridge	225 days	Fri 12/15/17	Thu 10/25/18
11	Planting	3 days	Fri 10/26/18	Tue 10/30/18
12	Demobilize	5 days	Wed 10/31/18	Tue 11/6/18
13	Finish	1 day	Wed 11/7/18	Wed 11/7/18



Project: Big Beef Creek Estuary
Date: Fri 3/25/16

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

Big Beef Creek Estuary

Preliminary Budget Estimate Level
Abbreviated Risk Analysis

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

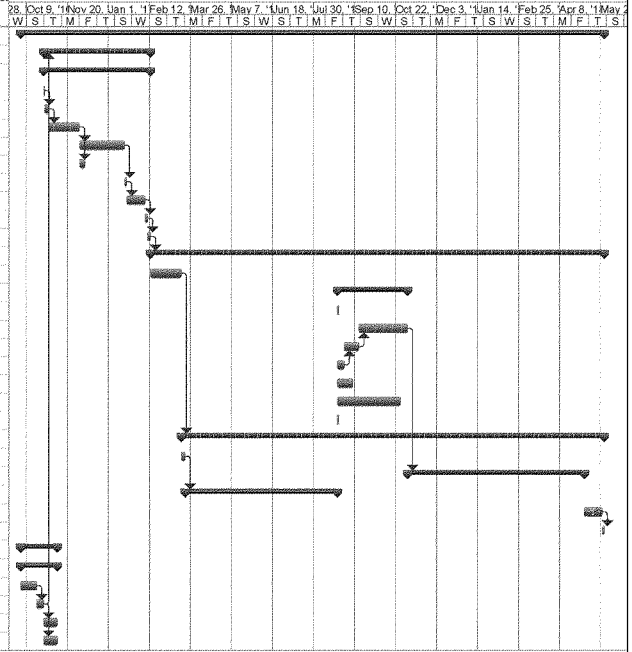
Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	06 Earthwork	No subsurface geotechnical exploration. Possibility for soil contamination? Preliminary planning stages and no grading details known. Care and Diversion of water.		LIKELY	Critical	5
PS-2	06 Demolition	Increased erosion following causeway removal could impact homes? Greater sediment outfall from the harbor disturbing native fishing grounds? Mitigation/compensation?		LIKELY	Critical	5
PS-4	08 Earthwork	No subsurface geotechnical exploration. Preliminary planning stages and no grading details known. Risk of excavated soil contamination or unsuitable soil for reuse as fill for roadway section.		LIKELY	Crisis	5
PS-5	08 Pavement	Assumed landfill disposal. There could be a potential opportunity in recycling the asphalt for a reduced disposal fee.		Very Unlikely	Negligible	0
PS-6	08 Utilities	Unknowns in all subsurface work. There may be more utilities than what is currently identified in the report. If utilities are discovered there may be challenges with causeway removal, and utility relocation?		LIKELY	Critical	5
PS-7	08 Traffic Control	Local authority desires that the existing road remain open during construction. Risk of the entire road needing to be shut down for the duration of construction for staging and construction operations?		Very Unlikely	Negligible	0
PS-8	08 Bridge	Are there concerns/risk of scour around bridge columns as a result of increased tidal flows after removal of the causeway. Will there be a risk of increased embedment depth, revised column number or design?		LIKELY	Crisis	5
PS-10	18 Cultural Resources Preservation	What happens if Cultural Resources are discovered?		Very Unlikely	Negligible	0
PS-12	Remaining Construction Items	No specific concerns aside from level of detail in scope and design.		LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Acquisition Strategy						
AS-1	06 Earthwork	This estimate assumes full and open acquisition. However, the prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from IFB full competition.		LIKELY	Critical	5
AS-2	06 Demolition	See AS-2		LIKELY	Critical	5
AS-4	08 Earthwork	See AS-2		LIKELY	Critical	5
AS-5	08 Pavement	See AS-2		LIKELY	Critical	5
AS-6	08 Utilities	Typically utility companies perform the relocations of their own utilities. The acquisition strategy may not have an impact on this work.		Very Unlikely	Critical	2
AS-7	08 Traffic Control	See AS-2		Very Unlikely	Negligible	0
AS-8	08 Bridge	See AS-2		Very Unlikely	Negligible	0
AS-10	18 Cultural Resources Preservation	See AS-2		Very Unlikely	Negligible	0

AS-12	Remaining Construction Items	See AS-2		LIKELY	Critical	5
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Construction Complexity						
CC-1	06 Earthwork	Care and diversion of water. Stockpile locations requiring additional easements for excavated earth for reuse.		LIKELY	Marginal	2
CC-2	06 Demolition	See CC-1		LIKELY	Marginal	2
CC-4	08 Earthwork	See CC-1		LIKELY	Marginal	2
CC-5	08 Pavement	No concerns.		Very Unlikely	Negligible	0
CC-6	08 Utilities	See CC-5		Very Unlikely	Negligible	0
CC-7	08 Traffic Control	Can the new bridge be constructed without significant closures to the entire roadway. Is a 15ft wide staging area enough for construction opperations? Additional traffic control required for full closures, how many full closures?		Very Unlikely	Negligible	0
CC-8	09 Bridge	Construction of bridge columns using temporary finger piers off of existing roadway.		LIKELY	Significant	4
CC-10	18 Cultural Resources Preservation			Very Unlikely	Negligible	0
CC-12	Remaining Construction Items	See CC-1		LIKELY	Marginal	2
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Volatile Commodities						
VC-1	06 Earthwork	Fuel prices		LIKELY	Negligible	1
VC-2	06 Demolition	See VC-1		LIKELY	Negligible	1
VC-4	08 Earthwork	See VC-1		LIKELY	Negligible	1
VC-5	08 Pavement	Fuel and Asphalt prices		LIKELY	Negligible	1
VC-6	08 Utilities	Cost increase in the material (conductor, lines, mains, etc.)		LIKELY	Marginal	2
VC-7	08 Traffic Control			Very Unlikely	Negligible	0
VC-8	09 Bridge	Concrete prices		Very Unlikely	Negligible	0
VC-10	18 Cultural Resources Preservation			Very Unlikely	Negligible	0
VC-12	Remaining Construction Items	See VC-1		LIKELY	Negligible	1
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Quantities						
Q-1	06 Earthwork	Very few cross sections, just typical sections used in quantity development.		LIKELY	Critical	5
Q-2	06 Demolition	No cross sections or details on the causeway. Material of the causeway unknown. The assumptions used for quantifying these items could be off.		LIKELY	Marginal	2
Q-4	08 Earthwork	Unknowing how much, if any, excavated material will be suitable for reuse.		LIKELY	Significant	4
Q-5	08 Pavement	Assumed depth.		Unlikely	Negligible	0
Q-6	08 Utilities	Unknown if there are additional underground utilities.		LIKELY	Significant	4
Q-7	08 Traffic Control			Very Unlikely	Negligible	0
Q-8	09 Bridge	Existing bridge design is unknown, column embedment depth, height, number, diameter were all assumed.		LIKELY	Significant	4
Q-10	18 Cultural Resources Preservation	Time spent on study is an estimate. Findings could lead to more time being required.		Very Unlikely	Negligible	0

C-12	Remaining Construction Items			LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Fabrication & Project Installed Equipment						
FI-1	06 Earthwork	No concerns.		Very Unlikely	Negligible	0
FI-2	06 Demolition	No concerns.		Very Unlikely	Negligible	0
FI-4	08 Earthwork	No concerns.		Very Unlikely	Negligible	0
FI-5	08 Pavement	No concerns.		Very Unlikely	Negligible	0
FI-6	08 Utilities	No concerns.		Very Unlikely	Negligible	0
FI-7	06 Traffic Control			Very Unlikely	Negligible	0
FI-8	08 Bridge	Temporary finger pier construction platforms for new bridge construction.		Very Unlikely	Negligible	0
FI-10	18 Cultural Resources Preservation			Very Unlikely	Negligible	0
FI-12	Remaining Construction Items			Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Cost Estimating Method						
CE-1	06 Earthwork	No concerns.		Very Unlikely	Negligible	0
CE-2	06 Demolition	No concerns.		LIKELY	Negligible	1
CE-4	08 Earthwork	No concerns.		Very Unlikely	Negligible	0
CE-5	08 Pavement	The quantity of reused fill 6,615 CY. Dependent on suitability of unknown causeway material.		Very Unlikely	Negligible	0
CE-6	08 Utilities	No concerns.		LIKELY	Significant	4
CE-7	06 Traffic Control	Estimate assumes no significant closures of the roadway; temporary construction traffic signal to facilitate one way road during construction.		Very Unlikely	Negligible	0
CE-8	08 Bridge	Production rate of installing temporary piers, and production rate for construciton of columns from temporary piers.		LIKELY	Significant	4
CE-10	18 Cultural Resources Preservation			Very Unlikely	Negligible	0
CE-12	Remaining Construction Items	There could be an increase in items covered and addition of items not covered.		LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
HTRW						
HTRW-1	06 Earthwork	Potential for soil contamination due to roadway runoff.		LIKELY	Crisis	5
HTRW-2	06 Demolition	Creosote hazard for demolition of the old pier.		LIKELY	Significant	4
HTRW-4	08 Earthwork	See HTRW-1.		LIKELY	Crisis	5
HTRW-5	08 Pavement	No Concerns.		Very Unlikely	Negligible	0
HTRW-6	08 Utilities	No Concerns.		Very Unlikely	Negligible	0
HTRW-7	08 Traffic Control			Very Unlikely	Negligible	0
HTRW-8	08 Bridge			Very Unlikely	Negligible	0
HTRW-10	18 Cultural Resources Preservation			Very Unlikely	Negligible	0
HTRW-12	Remaining Construction Items	No specific concerns at this time. There may be some impact here.		LIKELY	Marginal	2

PSNERP
Tahuya River Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predec
1	**ahuya Full Alternative Restoration**	**428 days**	**Mon 10/3/16**	**Thu 5/24/18**	
2	**[06] Fish and Wildlife Facilities**	**77.5 days**	**Wed 10/26/16**	**Mon 2/13/17**	46
3	**[06 03] Wildlife Facilities and Sanctuaries**	**77.5 days**	**Wed 10/26/16**	**Mon 2/13/17**	
4	Mobilization	8 hrs	Wed 10/26/16	Thu 10/27/16	
5	Preconstruction Survey	20 hrs	Thu 10/27/16	Tue 11/1/16	4
6	Erosion & Sediment Control Measures - Install Silt Fence	188 hrs	Tue 11/1/16	Fri 12/2/16	5
7	Earthwork	255 hrs	Fri 12/2/16	Tue 1/17/17	6
8	Demolition	27 hrs	Fri 12/2/16	Wed 12/7/16	6
9	Vegetation	20 hrs	Tue 1/17/17	Thu 1/19/17	7
10	Erosion & Sediment Control Measures - Remove silt fenc	101 hrs	Thu 1/19/17	Tue 2/7/17	9
11	Post Construction Survey	20 hrs	Tue 2/7/17	Fri 2/10/17	10
12	Demobilization	8 hrs	Fri 2/10/17	Mon 2/13/17	11
13	**[08] Roads, Railroads, and Bridges**	**333 days**	**Mon 2/13/17**	**Thu 5/24/18**	12
14	Erosion & Sediment Control Measures - Install Silt Fence	188 hrs	Mon 2/13/17	Thu 3/16/17	
15	**[08 01] Roads**	**51.63 days**	**Wed 8/23/17**	**Fri 11/3/17**	40
16	Mobilization	8 hrs	Wed 8/23/17	Thu 8/24/17	
17	Earthwork	286 hrs	Thu 9/14/17	Fri 11/3/17	18
18	Pavement	87 hrs	Wed 8/30/17	Thu 9/14/17	19
19	Parapet Wall	40 hrs	Wed 8/23/17	Wed 8/30/17	
20	Utilities	97 hrs	Wed 8/23/17	Fri 9/8/17	
21	Traffic Control	372 hrs	Wed 8/23/17	Fri 10/27/17	
22	Demobilization	8 hrs	Wed 8/23/17	Thu 8/24/17	
23	**Bridges**	**309.5 days**	**Thu 3/16/17**	**Thu 5/24/18**	14
24	Mobilization	16 hrs	Thu 3/16/17	Mon 3/20/17	
25	**Bridge Installation**	**129.25 days**	**Fri 11/3/17**	**Thu 5/3/18**	17
34	**Bridge Removal**	**112 days**	**Mon 3/20/17**	**Wed 8/23/17**	24
41	Erosion & Sediment Control Measures - Remove Silt Fen	101 hrs	Thu 5/3/18	Tue 5/22/18	32
42	Demobilization	16 hrs	Tue 5/22/18	Thu 5/24/18	41
43	**[18] Cultural Resource Preservation**	**27.5 days**	**Mon 10/3/16**	**Wed 11/9/16**	
44	**[18 00] Cultural Resource Preservation**	**27.5 days**	**Mon 10/3/16**	**Wed 11/9/16**	
45	Survey	100 hrs	Mon 10/3/16	Wed 10/19/16	
46	Report	40 hrs	Wed 10/19/16	Wed 10/26/16	45
47	Consultation	80 hrs	Wed 10/26/16	Wed 11/9/16	46
48	Potential NRHP Evaluation	80 hrs	Wed 10/26/16	Wed 11/9/16	46



Project: Tahuya River Estuary
Date: Fri 3/25/16

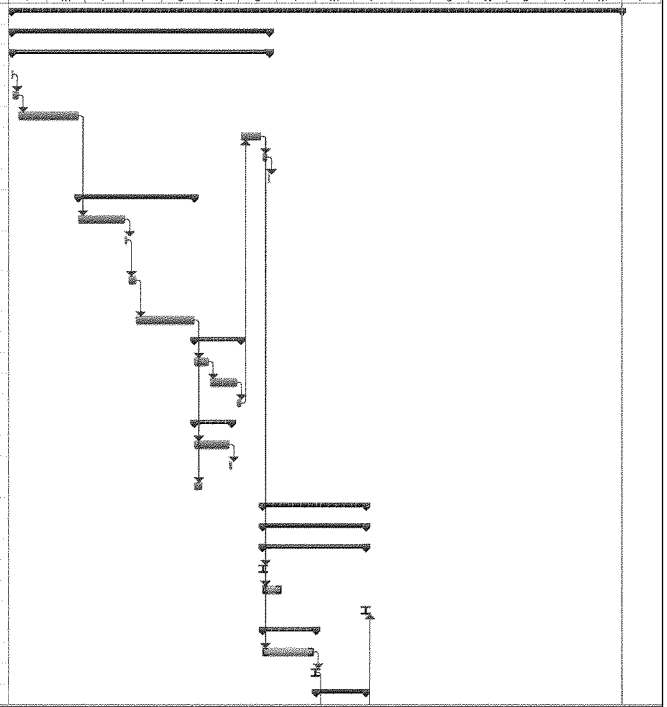
Task	External Tasks	Manual Task	Finish-only		
Split	External Milestone	Duration-only	Progress		
Milestone	Inactive Task	Manual Summary Rollup	Deadline		
Summary	Inactive Milestone	Manual Summary			
Project Summary	Inactive Summary	Start-only			

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PROJECT & PROGRAM MGMT									
PPM-1	Project Scheduling	High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.	PDT does not believe the volume of project will cause problems. Project will be schedule over years and even decades in order to meet construction goals.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-2	Staffing Reductions	Both the Seattle District and the WDFW have numerous projects competing for staffing resources. If other projects become a higher priority staff could be pulled from PSNERP.	PSNERP remains a District and WDFW priority and will is less likely than other projects to see staffing reductions. There are minor cost increases due to increases in work being out-sourced to AEs and potentiall slowdowns is staffing is shifted on short notice.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-3	Communication Issues	Excellent communications is necessary in order to sucessfully complete the project. Both internal issues intra-Corps or intra-WDFW, or issues between the Corps and local sponsors could affect the project timeline.	The project currently has strong communication and trust between the Corps and WDFW, and enjoys high levels of political support both from the Federal and local sponsors. There are other local sponsors (municipalities, tribes, NGOs, etc) that will be involved once the project moves into PED/CG phase. Communications with these entities may be more fraught and there are likely to be at least some schedule delays because of this.	Very Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-4	Poor Initial Project Perfomance	The PSNERP project will be very visible in the Puget Sound area once construction begins. Could an early action that performs poorly (reduced environmental benefits, project neighbors who felt slighted or whose concerns were not fully addressed, etc) cause the remainder of the project to have increased cost/schedule?	PDT believes its very unlikely that there would be a poorly performing initial project as the earliest projects that proceed to construction are likely to be those whose success is the most assured. Impacts would likely be delays to the start of projects, and costs other than increases due to inflation would be unlikely.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
CONTRACT ACQUISITION RISKS									
CA-1	Potenially Could Go Small Business	This estimate assumes full and open acquisition. However, the prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from IFB full competition.	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. Given the nature of this work it is felt that it could go small business. Also, other methods may be used as well. It is considered likely that the contracting method could change from what is proposed in the estimate.	Very Likely	Critical	HIGH	Very Likely	Critical	HIGH
CA-3	Inefficient Contractors	The acquisition process may higher inefficient contractors.	PDT believe that this is unlikely. Contracting language and selection processes can be done in a way that can filter out poor performing contractors.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
TECHNICAL RISKS									
TL-1	Earthwork	Preliminary planning stages and no grading details known. Helipad relocation location not yet identified.	There is the possibility that the areas of excavation and fill could change from what is presented in the draft report. Any increase in quantity will be covered in the Quantity risk element section. The risk here is that the nature of the earthwork may change. There could be additional requirements (not quantities) imposed in the excavation and fill. It is thought to be at least a 50% chance that the scope of the earthwork will change.	Likely	Significant	HIGH	Very Likely	Critical	HIGH

TL-2	Bridge work	No design for new bridge and no as-builts for existing bridge.	The bridge type is likely to change or some elements of the scope of the proposed bridge. The bridge construction is approximately 50% of the construction cost	Likely	Critical	HIGH	Very Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood***	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
	REGULATORY AND ENVIRONMENTAL								
RE-1	Cultural Resources	Per Ashley Dailide, NWS lead Archeologist: "There is a moderate potential for archaeological resources to exist within the project area. " Per Mary McCormick, NWS: "No previously recorded historic-age buildings or structures exist within the APE for the Tahuya Estuary."	"While there has been no previous surveys done within the project APE, there is a known archaeological site within a one mile radius of the project area. The entire APE will need to be surveyed, and if any archaeological resources are found, they will need to be tested and evaluated for the NRHP." "Consulted sources identified only one potential property, a bridge on the causeway which carries the NE North Shore Road across the estuary. The construction era of this county bridge is unknown. Other probable properties in the APE are small dikes, canal or other mundane structures associated with agricultural activities."	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
RE-2	Soil Contamination	Quantities of contaminated soil requiring excavation could vary significantly.	Extent and characterization of potential contamination has not been delineated yet. Impact will be significant since contaminated soil will have to trucked to an offsite landfill for disposal.	Likely	Marginal	MODERATE	Very Likely	Significant	HIGH
	CONSTRUCTION RISKS								
CON-4	Bridge Removal	Method of bridge demolition.	There could be different ways to perform this work. Without more information on the existing bridge, it is difficult to understand the full impact of this task. It could be much more cumbersome of a task than currently perceived.	Likely	Significant	HIGH	Very Unlikely	Negligible	LOW
	ESTIMATE AND SCHEDULE RISKS								
EST-1	Quantities	Many of the features have limited information, few cross-sections for earthwork, etc.	More information will be obtained as design progresses. It is likely that there will be a change in the quantities. Assume Significant impact.	Likely	Significant	HIGH	Likely	Significant	HIGH
EST-2	Cost book items	Many cost book items used for utilities and bridges.	Cost book items do not always reflect the site-conditions or do not represent the actual work required. Production rates are usually optimistic and material cost may be outdated.	Likely	Significant	HIGH	Very Likely	Significant	HIGH
	ECONOMICS RISKS								
FL-1	Fuel	Fuel prices are volatile and will probably go up	A 25% increase in fuel could contribute to up to a 2% increase in total construction costs. How likely is it that gasoline will reach $5.00/gal? Depends on who you ask. For the purposes of this risk analysis, assume that it is unlikely. Impact is significant.	Unlikely	Significant	MODERATE	Very Unlikely	Negligible	LOW
FL-2	Asphalt	Asphalt is a petroleum product and subject to fluctuation.	Assume likely and marginal.	Likely	Marginal	MODERATE	Very Unlikely	Negligible	LOW
FL-3	Concrete & Steel		These material costs are subject to market conditions. It is likely these will increase. The impact is considered to be negligible.	Likely	Negligible	LOW	Very Unlikely	Negligible	LOW

PSNERP
Lilliwaup Causeway
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Lillwaup Causeway Replacement**	**524 days**	**Mon 10/3/16**	**Thu 10/4/18**	
2	**Fish and Wildlife**	**221 days**	**Mon 10/3/16**	**Mon 8/7/17**	
3	**General**	**221 days**	**Mon 10/3/16**	**Mon 8/7/17**	
4	Mobilize	1 day	Mon 10/3/16	Mon 10/3/16	
5	Pre Survey	5 days	Tue 10/4/16	Mon 10/10/16	4
6	Place Silt Fence	52 days	Tue 10/11/16	Wed 12/21/16	5
7	Remove Silt Fence	18 days	Wed 7/5/17	Fri 7/28/17	18
8	Post Survey	5 days	Mon 7/31/17	Fri 8/4/17	7
9	Demob	1 day	Mon 8/7/17	Mon 8/7/17	8
10	**Earthwork**	**99 days**	**Thu 12/22/16**	**Tue 5/9/17**	
11	Excavate Tidal Channel	40 days	Thu 12/22/16	Wed 2/15/17	6
12	Excavate Rock & Concrete Debris	2 days	Thu 2/16/17	Fri 2/17/17	11
13	Excavate Roadway & Lillwaup Creek Embankment	7 days	Mon 2/20/17	Tue 2/28/17	12
14	Fill - Gravel	50 days	Wed 3/1/17	Tue 5/9/17	13
15	**Demolition**	**40 days**	**Wed 5/10/17**	**Tue 7/4/17**	
16	Bulkheads	13 days	Wed 5/10/17	Fri 5/26/17	14
17	Buildings (Three)	24 days	Mon 5/29/17	Thu 6/29/17	16
18	Utilties	3 days	Fri 6/30/17	Tue 7/4/17	17
19	**Vegeatation**	**33 days**	**Wed 5/10/17**	**Fri 6/23/17**	
20	Plantings	30 days	Wed 5/10/17	Tue 6/20/17	14
21	LWD	3 days	Wed 6/21/17	Fri 6/23/17	20
22	Dust Control	7 days	Wed 5/10/17	Thu 5/18/17	14
23	**Roads, Railroads, Bridges**	**90 days**	**Mon 7/31/17**	**Fri 12/1/17**	
24	**Roads**	**90 days**	**Mon 7/31/17**	**Fri 12/1/17**	
25	**General**	**90 days**	**Mon 7/31/17**	**Fri 12/1/17**	
26	Mobilize	1 day	Mon 7/31/17	Mon 7/31/17	7
27	Street Cleaning	16 days	Mon 7/31/17	Mon 8/21/17	7
28	Demob	1 day	Fri 12/1/17	Fri 12/1/17	36
29	**Earthwork**	**46 days**	**Mon 7/31/17**	**Mon 10/2/17**	
30	Excavate Highway 101	45 days	Mon 7/31/17	Fri 9/29/17	7
31	Fill - Highway 101	1 day	Mon 10/2/17	Mon 10/2/17	30
32	**Pavement**	**44 days**	**Tue 10/3/17**	**Fri 12/1/17**	



Project: Lilliwaup Causeway
Date: Fri 3/25/16

Task	External Tasks	Manual Task	Finish-only		
Split	External Milestone	Duration-only	Deadline		
Milestone	Inactive Task	Manual Summary Rollup	Progress		
Summary	Inactive Milestone	Manual Summary			
Project Summary	Inactive Summary	Start-only			

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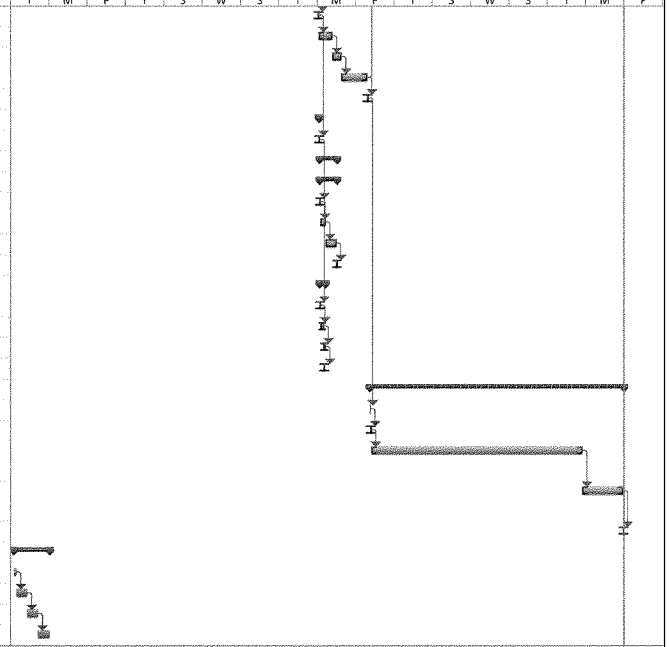
PSNERP
Lilliwaup Causeway
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
33	Mobilize	1 day	Tue 10/3/17	Tue 10/3/17	31
34	Demolition	12 days	Wed 10/4/17	Thu 10/19/17	33
35	Place Highway 101	7 days	Fri 10/20/17	Mon 10/30/17	34
36	Place Lillwaup Road	23 days	Tue 10/31/17	Thu 11/30/17	35
37	Demobilize	1 day	Fri 12/1/17	Fri 12/1/17	36
38	**Drainage**	**1 day**	**Wed 10/4/17**	**Wed 10/4/17**	
39	Demo	1 day	Wed 10/4/17	Wed 10/4/17	33
40	**Relocate Utilties**	**15 days**	**Thu 10/5/17**	**Wed 10/25/17**	
41	**Power**	**15 days**	**Thu 10/5/17**	**Wed 10/25/17**	
42	Mobilize	1 day	Thu 10/5/17	Thu 10/5/17	39
43	Demo Power	4 days	Fri 10/6/17	Wed 10/11/17	42
44	Install New Power	9 days	Thu 10/12/17	Tue 10/24/17	43
45	Demobilze	1 day	Wed 10/25/17	Wed 10/25/17	44
46	**Telecommunications**	**5 days**	**Thu 10/5/17**	**Wed 10/11/17**	
47	Mobilize	1 day	Thu 10/5/17	Thu 10/5/17	39
48	Demo Telecom	2 days	Fri 10/6/17	Mon 10/9/17	47
49	Install New Telecom	3 days	Mon 10/9/17	Wed 10/11/17	48
50	Demobilze	1 day	Tue 10/10/17	Tue 10/10/17	49
51	**Bridge**	**219 days**	**Mon 12/4/17**	**Thu 10/4/18**	
52	Mobilize	1 day	Mon 12/4/17	Mon 12/4/17	37
53	Crane Testing	1 day	Tue 12/5/17	Tue 12/5/17	52
54	Placement of New Highway 101	181 days	Wed 12/6/17	Wed 8/15/18	53
55	Demolition of Old Highway 101	35 days	Thu 8/16/18	Wed 10/3/18	54
56	Demobilze	1 day	Thu 10/4/18	Thu 10/4/18	55
57	**Cultural Resource Preservation**	**31 days**	**Mon 10/3/16**	**Mon 11/14/16**	
58	Survey	3 days	Mon 10/3/16	Wed 10/5/16	
59	Report	9 days	Thu 10/6/16	Tue 10/18/16	58
60	Consultation	9 days	Wed 10/19/16	Mon 10/31/16	59
61	Potential NRHP-Evaluation	10 days	Tue 11/1/16	Mon 11/14/16	60



Project: Lilliwaup Causeway
Date: Fri 3/25/16

Task	External Tasks	Manual Task	Finish-only		
Split	External Milestone	Duration-only	Deadline		
Milestone	Inactive Task	Manual Summary Rollup	Progress		
Summary	Inactive Milestone	Manual Summary			
Project Summary	Inactive Summary	Start-only			

Lilliwaup Creek Estuary

Preliminary Budget Estimate Level
Abbreviated Risk Analysis

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	06 Earthwork	Preliminary planning stages and no grading details known.	There is the possibility that the areas of excavation and fill could change from what is presented in the draft report. Any increase in quantity will be covered in the Quantity risk element section. The risk here is that the nature of the earthwork may change. There could be additional requirements (not quantities) imposed in the excavation and fill. It is thought to be at least a 50% chance that the scope of the earthwork will change. Impact is assumed to be marginal.	LIKELY	Marginal	2
PS-2	06 Demolition	No specific information is known about the structures to be removed.	Possibility for some scope change due to unknowns. Likely for scope to change. Impact assumed to be negligible.	LIKELY	Negligible	1
PS-4	08 Earthwork	See PS-1. Interchange design of Lilliwaup Street and Hwy 101 may not meet standards.	See Ps-1. Assume likely risk to occur with an assumed significant impact.	LIKELY	Significant	4
PS-5	Pavement	Preliminary stage of project planning. Assumed landfill disposal. There could be a potential opportunity in recycling the asphalt for a reduced disposal fee.	This risk analysis does no account for opportunities (cost savings). However it should be noted in the Risk Register. There are risks in the quantities, but that will be covered in the Quantity risk element. No other concerns with this item.	Unlikely	Negligible	0
PS-6	Bridge Removal	See PS-5. No as-built drawings.		Unlikely	Negligible	0
PS-7	Bridge Installation	No design. Same typical section used for all of the bridges.	The bridge type is likely to change or some elements of the scope of the proposed bridge. The bridge is approximately 37% of the construction cost. Curvature in bridge may present design differing from what is proposed. Could easily increase TPC over 5%.	LIKELY	Critical	5
PS-8	18 Cultural Resources Preservation	Per Ashley Dallide, NWS lead Archeologist: "While there has been no previous work done in this area, based on the landforms, there is a moderate potential for archaeological resources to exist within the project area."	"The entire APE will need to be surveyed, and if any archaeological resources are found, they will need to be tested and evaluated for the NRHP".	Unlikely	Marginal	1
PS-12	Remaining Construction Items	No specific concerns aside from level of detail in scope and design.	Likely unknowns at this point in all aspects of the work. Impact could have between a 1% and 5% increase to project costs.	LIKELY	Significant	4
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Acquisition Strategy						
AS-1	06 Earthwork	This estimate assumes full and open acquisition. However, the prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from IFB full competition.	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. Given the nature of this work it is felt that it could go small business. Also, other methods may be used as well. It is considered likely that the contracting method could change from what is proposed in the estimate. The impact could be up to 10%.	LIKELY	Critical	5
AS-2	06 Demolition	See AS-1		LIKELY	Critical	5
AS-4	08 Earthwork	See AS-1		LIKELY	Critical	5
AS-5	Pavement	See AS-1		LIKELY	Critical	5
AS-6	Bridge Removal	See AS-1		LIKELY	Critical	5
AS-7	Bridge Installation	See AS-1		LIKELY	Critical	5

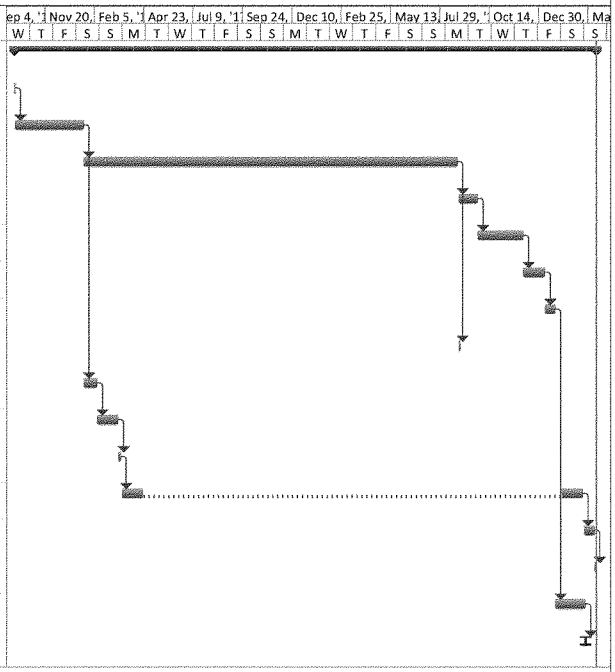
AS-8	18 Cultural Resources Preservation	Not applicable		Very LIKELY	Critical	5
AS-12	Remaining Construction Items	See AS-1		LIKELY	Critical	5
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Construction Complexity						
CC-1	06 Earthwork	No concerns at this time.		Unlikely	Negligible	0
CC-2	06 Demolition			Unlikely	Negligible	0
CC-4	08 Earthwork			Unlikely	Negligible	0
CC-5	Pavement			Unlikely	Negligible	0
CC-6	Bridge Removal	Method of bridge demolition	There could be different ways to perform this work. Without more information on the existing bridge, it is difficult to understand the full impact of this task. It could be much more cumbersome of a task than currently perceived.	Unlikely	Marginal	1
CC-7	Bridge Installation	Pretty standard cross section.	If scope of work adheres to what is presented in the report, this is pretty straight forward bridge work. Assume unlikely and marginal.	Unlikely	Marginal	1
CC-8	18 Cultural Resources Preservation	No concerns at this time.		Very Unlikely	Negligible	0
CC-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Volatile Commodities						
VC-1	06 Earthwork	Fuel prices	A 25% increase in fuel could contribute to up to a 3% increase in total construction costs. How likely is it that gasoline will reach $5.00/gal? Depends on who you ask. For the purposes of this risk analysis, assume that it is unlikely. Impact is significant	Unlikely	Significant	3
VC-2	06 Demolition	See VC-1	Assume negligible.	Unlikely	Negligible	0
VC-4	08 Earthwork	See VC-1		Unlikely	Significant	3
VC-5	Pavement	Fuel prices. Asphalt.	Asphalt is a petroleum product and subject to fluctuation. Assume likely and marginal.	LIKELY	Marginal	2
VC-6	Bridge Removal	See VC-1		Unlikely	Significant	3
VC-7	Bridge Installation	Concrete, steel.	These material costs are subject to market conditions. It is likely these will increase. The impact is considered to be negligible.	LIKELY	Negligible	1
VC-8	18 Cultural Resources Preservation	No concerns at this time.		Very Unlikely	Negligible	0
VC-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Quantities						
Q-1	06 Earthwork	Very few cross sections, just typical sections used in quantity development.	More information will be obtained as design progresses. It is likely that there will be a change in the quantities. Likely a change in quantities and it could cause the estimate to increase by 1%	LIKELY	Marginal	2
Q-2	06 Demolition	No specific information is known about the structures to be removed.	Likely quantities will increase and impact is assumed negligible.	LIKELY	Negligible	1
Q-4	08 Earthwork	See Q-1		LIKELY	Marginal	2
Q-5	Pavement	Assumed depth of removal. Asphalt placement design subject to change.	Likely to change. Impact is difficult to evaluate since disposal fees are the largest cost in demolition. Changes in asphalt placement could increase costs.	LIKELY	Marginal	2

Q-6	Bridge Removal	Many assumptions made.	Clarification will only occur as design progresses. Potential here for more material to be removed from the site and disposed of. It is believed this is likely to occur and assumed to have a marginal impact.	LIKELY	Marginal	2
Q-7	Bridge Installation	Used a typical section for the quantity development.	Conservative in the caisson depth. Many assumptions were made. It is likely that the quantities will change. The impact is though to have the potential to raise the TPC by up to 5%.	LIKELY	Significant	4
Q-8	18 Cultural Resources Preservation	Time spent on study is an estimate.	Findings could lead to more time being required.	LIKELY	Significant	4
Q-12	Remaining Construction Items	Preliminary design and early planning stage.	Potential here for more quantities needed.	LIKELY	Marginal	2
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Fabrication & Project Installed Equipment						
FI-1	06 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
FI-2	06 Demolition	No concerns at this time.		Very Unlikely	Negligible	0
FI-4	08 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
FI-5	Pavement	No concerns at this time.		Very Unlikely	Negligible	0
FI-6	Bridge Removal	No concerns at this time.		Very Unlikely	Negligible	0
FI-7	Bridge Installation	No concerns at this time.		Very Unlikely	Negligible	0
FI-8	18 Cultural Resources Preservation	No concerns at this time.		Very Unlikely	Negligible	0
FI-12	Remaining Construction Items	No concerns at this time.		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Cost Estimating Method						
CE-1	06 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
CE-2	06 Demolition	No concerns at this time.		LIKELY	Marginal	2
CE-4	08 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
CE-5	Pavement	No concerns at this time.		Very Unlikely	Negligible	0
CE-6	Bridge Removal	Made assumptions.	Assumptions may not be valid.	LIKELY	Marginal	2
CE-7	Bridge Installation	Used many cost book items. Used many assumptions.	Cost book items and assumptions may not be entirely accurate or applicable to the project. It is likely there will be changes to cost model for the bridge as the	LIKELY	Significant	4
CE-8	18 Cultural Resources Preservation	Made assumptions.	Assumptions may not be valid.	LIKELY	Significant	4
CE-12	Remaining Construction Items			Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
External Project Risks						
EX-1	06 Earthwork	No concerns at this time.		Unlikely	Negligible	0
EX-2	06 Demolition	No concerns at this time.		Very Unlikely	Negligible	0
EX-4	08 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
EX-5	Pavement	No concerns at this time.		Very Unlikely	Negligible	0
EX-6	Bridge Removal	No concerns at this time.		Very Unlikely	Negligible	0
EX-7	Bridge Installation	No concerns at this time.		Very Unlikely	Negligible	0
EX-8	18 Cultural Resources Preservation	No concerns at this time.		Very Unlikely	Negligible	0
EX-12	Remaining Construction Items	No concerns at this time.		Very Unlikely	Negligible	0

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
HTRW						
HTRW-1	06 Earthwork	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-2	06 Demolition	Potential for asbestos material in some of the structures proposed for removal. Potential for underground storage tanks (USTs) associated with the structures.	Individual structures were not assessed in the Phase I survey, and additional investigation is needed to characterize potential asbestos/lead contamination on the structures proposed for removal.	LIKELY	Marginal	2
HTRW-4	08 Earthwork	No concerns at this time.		Unlikely	Negligible	0
HTRW-5	Pavement	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-6	Bridge Removal	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-7	Bridge Installation	No concerns at this time.		Very Unlikely	Negligible	0
HTRW-8	18 Cultural Resources Preservation	Not applicable.		Very Unlikely	Negligible	0
HTRW-12	Remaining Construction Items	No concerns at this time.		Unlikely	Negligible	0

PSNERP
Big Quilcene River
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Bug Quilcene Delta**	**650 days**	**Mon 10/3/16**	**Fri 3/29/19**	
2	Start	1 day	Mon 10/3/16	Mon 10/3/16	
3	Site Prep	77 days	Tue 10/4/16	Wed 1/18/17	2
4	New LL Road Bridge	417 days	Thu 1/19/17	Fri 8/24/18	3
5	Build New LL Road	22 days	Mon 8/27/18	Tue 9/25/18	4
6	Remove LL Bridge	51 days	Wed 9/26/18	Wed 12/5/18	5
7	Demo LL Road	24 days	Thu 12/6/18	Tue 1/8/19	6
8	Other Road Demo	12 days	Wed 1/9/19	Thu 1/24/19	7
9	Pilot Channel	3 days	Mon 8/27/18	Wed 8/29/18	4
10	Demo Buildings	15 days	Thu 1/19/17	Wed 2/8/17	3
11	Demo Utility	23 days	Thu 2/9/17	Mon 3/13/17	10
12	Build Setback Levee	4 days	Tue 3/14/17	Fri 3/17/17	11
13	Remove South Dike	49 days	Mon 3/20/17	Fri 3/8/19	12
14	Remove North Dike	12 days	Mon 3/11/19	Tue 3/26/19	13
15	Reinforce South Dike	3 days	Wed 3/27/19	Fri 3/29/19	14
16	Revegetate	33 days	Fri 1/25/19	Tue 3/12/19	8
17	Finish	1 day	Wed 3/13/19	Wed 3/13/19	16



Project: Big Quilcene River
Date: Fri 3/25/16

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

Big Quilcene River

Preliminary Budget Estimate Level
Abbreviated Risk Analysis

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	4	5	5
Unlikely	0	1	3	3	4
Very Unlikely	0	0	1	2	4

Risk Element	Potential Risk Areas	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope						
PS-1	Demo Buildings	Buildings are not well defined.	Report does not establish a great deal of detail regarding buildings types, sizes, or features. It was assumed that all buildings are single story, wood frame, with relatively simple foundations. It is very likely that there would be some variation in this. A 10% increase in this cost would be a negligible impact overall.	Very LIKELY	Negligible	2
PS-2	Roads	Bridge design is based on a section used among all PSNERP sites.	PDT believes bridge design is fairly conservative for this site. Very unlikely that there would be substantial changes. However, even a small change could have a significant total project impact given the cost of the bridge relative to the all the other aspects of work.	Very Unlikely	Significant	1
PS-3	Create Pilot Channel	No concerns		Very Unlikely	Negligible	0
PS-4	Levees	Levee settlement	Geotechnical investigations have not been conducted at this site and it is possible that substantial settlement would occur. PDT believes this is very likely and that material for the levee could increase by 50%. This could increase project cost by 1.3%	Very LIKELY	Significant	4
PS-8	Cultural Resource Preservation	A prehistoric battleground is present	Very likely something of significance would be found. Cultural Resource team member believes there would be marginal overall cost and schedule impacts.	Very LIKELY	Marginal	3
PS-9	Built Environment Analysis	Risks due to on-site buildings and dikes.	PDT believes the following: Very likely that there is some national register eligible projects (dikes - less likely, buildings, bridge) In some cases, construction has stopped, but hard to tell now. Marginal costs.	Very LIKELY	Marginal	3
PS-12	Remaining Construction Items	Preliminary design.	There are likely elements of the other associated work that are not included in the project. Elements that are included in the work are likely to change as well. These impacts are unlikely to exceed 1.0% of total cost.	LIKELY	Marginal	2
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Acquisition Strategy						
AS-1	Demo Buildings	Acquisition strategy is currently not defined. This estimate assumes full and open acquisition. However, the prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from full and open competition.	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be under 0.5%	Unlikely	Negligible	0
AS-2	Roads	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be 8.9%	Unlikely	Critical	3

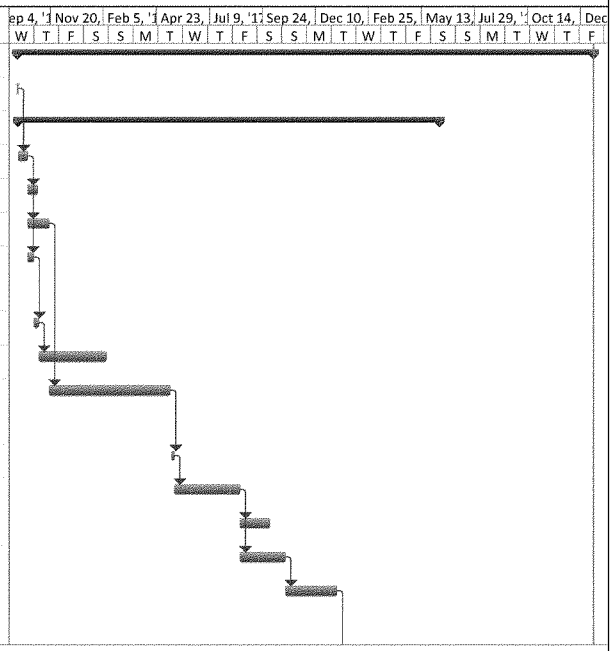
AS-3	Create Pilot Channel	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be under 0.5%	Unlikely	Negligible	0
AS-4	Levees	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given its relatively simple scope could go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be 0.6%	Unlikely	Marginal	1
AS-8	Cultural Resource Preservation	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be under 0.5%	Unlikely	Negligible	0
AS-9	Built Environment Analysis	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be under 0.5%	Unlikely	Negligible	0
AS-12	Remaining Construction Items	See AS-1	Typically if a project goes small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. This project, given the complicated nature of bridge construction is unlikely to go small business and increase feature cost by 10% due to increased markups. Total cost impacts based on this feature would be under 0.5%	Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Construction Complexity						
CC-1	Demo Buildings	No concerns		Very Unlikely	Negligible	0
CC-2	Roads	Bridge is assumed to be constructible from land	Construction of Linger Longer Rd Bridge is assumed to be conducted from the land surrounding the bridge. If this is not possible due to soil conditions or property owner limitations, there could be higher costs to complete this work. This is not believed to be likely, however a 10% increase in bridge costs would increase the total project cost by 8%.	Unlikely	Critical	3
CC-3	Create Pilot Channel	Area where work is occurring is assumed to be open to equipment	It was assumed that the entire area where the channel is being dug would be accessible to tracked equipment. If soil conditions are not suitable, or if the area where the vehicles can operate is constrained by biological elements, productivity will slow. A 10% slowdown will cause a negligible increase in cost	LIKELY	Negligible	1
CC-4	Levees	Area where work is occurring is assumed to be open to equipment	Conditions were assumed to be suitable for the use of large tracked equipment. If this is found to be otherwise, there could be cost increases. Given the large area where levees are being removed and installed, and their proximity to the river, some level of slowdown is likely. A 10% slowdown would cause a 0.52% cost increase to the project	LIKELY	Marginal	2
CC-8	Cultural Resource Preservation	No concerns		Very Unlikely	Negligible	0

CC-9	Built Environment Analysis	No concerns		Very Unlikely	Negligible	0
CC-12	Remaining Construction Items	No concerns.		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Volatile Commodities						
VC-1	Demo Buildings	No concerns.		Very Unlikely	Negligible	0
VC-2	Roads	Concrete price increases.	Since this is a large concrete bridge, it is vulnerable to increases in the price of pre-cast and ready-mix concrete. Given that the construction industry is in a relative slump, it is likely that material prices will increase as the industry turns around in the future. A 15% increase in concrete based materials would cause an overall cost impact of 2%.	LIKELY	Significant	4
VC-3	Create Pilot Channel	Fuel cost increases.	Fuel costs for the equipment and the hauling. An increase of 25% in fuel costs increases the total project cost less than 0.5%.	LIKELY	Negligible	1
VC-4	Levees	Imported fill material could increase in cost.	A 10% increase in material cost would have a 0.23% impact on total cost. A cost increase of this size is considered likely, due to the fact that current material prices were obtained in a period of construction industry slump. Prices are likely to increase once the industry regains strength.	LIKELY	Negligible	1
VC-8	Cultural Resource Preservation	No concerns.		Very Unlikely	Negligible	0
VC-9	Built Environment Analysis	No concerns.		Very Unlikely	Negligible	0
VC-12	Remaining Construction Items	No concerns.		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Quantities						
Q-1	Demo Buildings	Potential for additional houses being removed.	PDT believes there is a very high chance that additional houses will need to be removed. If the current number of houses increases from 5 to 10, the impact on the total project cost would be 2.9%.	Very LIKELY	Significant	4
Q-2	Roads	Numerous quantity assumptions made for road removal quantities.	Several roads were noted in the PDR as being removed but no independent calculation of their quantities was possible, and quantities were note provided in the report itself. Assumptions were made regarding the amount of road being removed, but it is very likely that there will be some sort of difference. A 20% increase in the quantity of roadway being demolished would cause a 0.4% increase in total project cost.	Very LIKELY	Negligible	2
Q-3	Create Pilot Channel	No concerns.		Very Unlikely	Negligible	0
Q-4	Levees	Levee slope changes.	Current levee slopes are 2:1. It is likely that slopes will increase to 2.5:1 or 3:1. This would substantially increase material required for import since not only would the levee footprint be larger, but additional material would be required to account for the increased settlement. This could potentially double the amount of material required. Total cost impact would be 2.7%.	LIKELY	Significant	4
Q-8	Cultural Resource Preservation			Very Unlikely	Negligible	0
Q-9	Built Environment Analysis			Very Unlikely	Negligible	0
Q-12	Remaining Construction Items	Preliminary design. Quantities subject to change.	be marginal.	Very LIKELY	Marginal	3
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
Fabrication & Project Installed Equipment						
FI-1	Demo Buildings	No concerns.		Very Unlikely	Negligible	0
FI-2	Roads	No concerns.		Very Unlikely	Negligible	0
FI-3	Create Pilot Channel	No concerns.		Very Unlikely	Negligible	0
FI-4	Levees	No concerns.		Very Unlikely	Negligible	0
FI-8	Cultural Resource Preservation	No concerns.		Very Unlikely	Negligible	0
FI-9	Built Environment Analysis	No concerns.		Very Unlikely	Negligible	0
FI-12	Remaining Construction Items	No concerns.		Very Unlikely	Negligible	0
Risk	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions**	**Likelihood**	**Impact**	**Risk**

Element	Potential Risk Areas	Concerns	(Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Level
Cost Estimating Method						
CE-1	Demo Buildings	No concerns	Methodology is conservative.	Very Unlikely	Negligible	0
CE-2	Roads	No concerns	Methodology is conservative.	Very Unlikely	Negligible	0
CE-3	Create Pilot Channel	Sidecasting of excavated soil was assumed	Material was assumed to be sidecast next to the channel and not hauled offsite for disposal. It is unlikely that this would not be acceptable, but if offsite disposal is necessary there will be increased costs. Double handling of material and disposal costs will be added to the cost of doing the work. Overall cost increase would be marginal.	Unlikely	Marginal	1
CE-4	Levees	Stockpiling of material was assumed to occur at no additional cost.	No site has been identified yet for stockpiling material. PDT believes this is very unlikely to be an issue since there is Jefferson County land nearby that should be available for no additional charge.	Very Unlikely	Marginal	0
CE-8	Cultural Resource Preservation	No concerns	Used Archaeologist provided data.	Very Unlikely	Negligible	0
CE-9	Built Environment Analysis	No concerns	Used Archaeologist provided data.	Very Unlikely	Negligible	0
CE-12	Remaining Construction Items	Many assumptions made.	Could increase costs would be marginal.	LIKELY	Marginal	2
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
External Project Risks						
EX-1	Demo Buildings	No concerns	Risk of buildings being declared historical was discussed elsewhere.	Very Unlikely	Negligible	0
EX-2	Roads	Existing bridge will be used as a point to assemble new bridge.	County will require road to be open at all times. PDT believes it is very unlikely that the proposed method can't be used. If bridge needs to be assembled through barging, there would be a marginal cost increase.	Very Unlikely	Marginal	0
EX-3	Create Pilot Channel	No concerns		Very Unlikely	Negligible	0
EX-4	Levees	Removing levees exposes BPA transmission towers to potential flooding.	PDT believes it's very likely that some level of reinforcement would be required for the towers. Most likely this would be to create berms around the towers. This could be a significant cost.	Very LIKELY	Significant	4
EX-8	Cultural Resource Preservation	No concerns		Very Unlikely	Negligible	0
EX-9	Built Environment Analysis	No concerns		Very Unlikely	Negligible	0
EX-12	Remaining Construction Items	No concerns		Very Unlikely	Negligible	0
Risk Element	**Potential Risk Areas**	**Concerns**	**PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)**	**Likelihood**	**Impact**	**Risk Level**
HTRW						
HTRW-1	Demo Buildings	Potential for asbestos, lead paint, etc.	HTRW team member believes buildings are likely to contain standard building contaminants. Marginal overall impact.	Very LIKELY	Marginal	3
HTRW-2	Roads	Potential for petroleum contamination from vehicles.	HTRW team member does not believe this to be a concern. Unlikely contamination would be at a level that would require removal.	Very Unlikely	Negligible	0
HTRW-3	Create Pilot Channel	Possible soil contamination from human habitation.	PDT believes this is unlikely to occur. If it does, costs would be marginal due to the small size of the soil being removed.	Unlikely	Marginal	1
HTRW-4	Levees	Potential soil related contamination.	HTRW report mentions it is likely that some contamination will be found in soils. If soil must be removed, there could be significant cost impacts.	LIKELY	Significant	4
HTRW-8	Cultural Resource Preservation	No concerns.		Very Unlikely	Negligible	0
HTRW-9	Built Environment Analysis	No concerns.		Very Unlikely	Negligible	0
HTRW-12	Remaining Construction Items	A variety of minor site features being demoed could contain HTRW substances.	Likely that something would be encountered, but disposal would be straightforward and relatively inexpensive. Marginal cost impacts due to minor nature of expected finds.	LIKELY	Marginal	2

PSNERP
Snohomish Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Snohomish River Estuary**	**599 days**	**Mon 10/3/16**	**Thu 1/17/19**	
2	Start	1 day	Mon 10/3/16	Mon 10/3/16	
3	**Distribution Channel**	**438 days**	**Tue 10/4/16**	**Thu 6/7/18**	
4	Mobilize	10 days	Tue 10/4/16	Mon 10/17/16	2
5	Survey	10 days	Tue 10/18/16	Mon 10/31/16	4
6	Clear and Grub	23 days	Tue 10/18/16	Thu 11/17/16	4
7	Build Temporary Roadway	7 days	Tue 10/18/16	Wed 10/26/16	4
8	Demo Boat Ramp	5 days	Thu 10/27/16	Wed 11/2/16	7
9	Demo Buildings	70 days	Thu 11/3/16	Wed 2/8/17	8
10	Distribution Channel Excavation	126 days	Fri 11/18/16	Fri 5/12/17	6
11	Culvert Installation	4 days	Mon 5/15/17	Thu 5/18/17	10
12	Levee Construction	67 days	Fri 5/19/17	Mon 8/21/17	11
13	Eroision Protection	31 days	Tue 8/22/17	Tue 10/3/17	12
14	Road Demo	48 days	Tue 8/22/17	Thu 10/26/17	12
15	New Road Construction	53 days	Fri 10/27/17	Tue 1/9/18	14

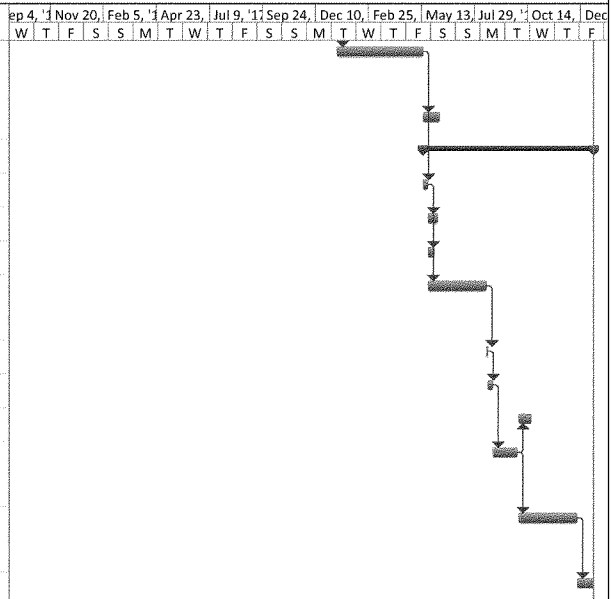


Project: Snohomish Estuary
Date: Fri 3/25/16

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

PSNERP
Snohomish Estuary
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
16	New Bridge Construction	89 days	Wed 1/10/18	Mon 5/14/18	15
17	Vegetation	18 days	Tue 5/15/18	Thu 6/7/18	16
18	**Blind Channel**	**178 days**	**Tue 5/15/18**	**Thu 1/17/19**	
19	Mobilize	5 days	Tue 5/15/18	Mon 5/21/18	16
20	Survey	10 days	Tue 5/22/18	Mon 6/4/18	19
21	Clear and Grub	7 days	Tue 5/22/18	Wed 5/30/18	19
22	Blind Channel Excavation	61 days	Tue 5/22/18	Tue 8/14/18	19
23	Culvert Installation	2 days	Wed 8/15/18	Thu 8/16/18	22
24	Berm Construction	5 days	Fri 8/17/18	Thu 8/23/18	23
25	Road Demo	14 days	Mon 10/1/18	Thu 10/18/18	26
26	New Road Construction	26 days	Fri 8/24/18	Fri 9/28/18	24
27	New Bridge Construction	61 days	Mon 10/1/18	Mon 12/24/18	26
28	Vegetation	18 days	Tue 12/25/18	Thu 1/17/19	27



Project: Snohomish Estuary
Date: Fri 3/25/16

Task	External Milestone	Manual Summary Rollup	
Split	Inactive Task	Manual Summary	
Milestone	Inactive Milestone	Start-only	
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Project Summary	Manual Task	Deadline	
External Tasks	Duration-only	Progress	

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PROJECT & PROGRAM MGMT									
PPM-1	Project Scheduling	High volume of projects under the PSNERP authorization may present issues in terms of resource allocation and quality control.	PDT does not believe the volume of project will cause problems. Project will be schedule over years and even decades in order to meet construction goals.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-2	Staffing Reductions	Both the Seattle District and the WDFW have numerous projects competing for staffing resources. If other projects become a higher priority staff could be pulled from PSNERP.	PSNERP remains a District and WDFW priority and will is less likely than other projects to see staffing reductions. There are minor cost increases due to increases in work being out-sourced to AEs and potential slowdowns is staffing is shifted on short notice.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
PPM-3	Communication Issues	Excellent communications is necessary in order to successfully complete the project. Both internal issues intra-Corps or intra-WDFW, or issues between the Corps and local sponsors could affect the project timeline.	The project currently has strong communication and trust between the Corps and WDFW, and enjoys high levels of political support both from the Federal and local sponsors. There are other local sponsors (municipalities, tribes, NGOs, etc.) that will be involved once the project moves into PED/CG phase. Communications with these entities may be more fraught and there are likely to be at least some schedule delays because of this.	Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
PPM-4	Poor Initial Project Performance	The PSNERP project will be very visible in the Puget Sound area once construction begins. Could an early action that performs poorly (reduced environmental benefits, project neighbors who felt slighted or whose concerns were not fully addressed, etc.) cause the remainder of the project to have increased cost/schedule?	PDT believes its very unlikely that there would be a poorly performing initial project as the earliest projects that proceed to construction are likely to be those whose success is the most assured. Impacts would likely be delays to the start of projects, and costs other than increases due to inflation would be unlikely.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Project Cost**			**Project Schedule**		
				Likelihood*	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
CONTRACT ACQUISITION RISKS									
CA-1	Potentially Could Go Small Business	This estimate assumes SB open acquisition. The prime contractor is doing no work. All the work done is done by subcontractors. This project could be acquired by other methods aside from SB open competition. The size of this project is very large. The project will probably be constructed under multiple acquisitions.	Typically if a project goes very restrictive small business the amount of subcontracting and the overhead rates increase. Subcontracting should not be much of the risk for this project since everything is subbed out. If this went small business the overhead would increase. Other strategies could also increase costs. Given the nature of this work it is felt that it could go small business. Also, other methods may be used as well. It is considered likely that the contracting method could change from what is proposed in the estimate. The impact could be up to 10%.	Likely	Critical	HIGH	Likely	Marginal	MODERATE
CA-3	Inefficient Contractors	The acquisition process may higher inefficient contractors.	PDT believe that this is unlikely. Contracting language and selection processes can be done in a way that can filter out poor performing contractors.	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
Risk No.	**Risk/Opportunity Event**	**Concerns**	**PDT Discussions & Conclusions**	**Project Cost**			**Project Schedule**		
				Likelihood*	**Impact***	**Risk Level***	**Likelihood***	**Impact***	**Risk Level***
TECHNICAL RISKS									
TL-1	Earthwork - Blind Slough	Unanticipated ground conditions	Based on the small area unlikely, but if there were some the impact would be small	Very Likely	Significant	HIGH	Likely	Marginal	MODERATE
TL-2	Earthwork - Distributary Channel	Unanticipated ground conditions	Based on cleaning and widening an existing channel unlikely, but if there were some, the impact would be small	Very Likely	Critical	HIGH	Likely	Critical	HIGH

TL-3	Bridge Placement	No design. Same typical section used for all of the bridges. Seismic requirements.	The bridge type is likely to change or some elements of the scope of the proposed bridge. The bridge is approximately under 10% of the construction cost.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
TL-4	Earthwork Distributary Channel Levee	Unanticipated ground conditions	Even with good exploration, difficult ground conditions can be encountered, may need a dragline to complete this effort is there is a lot of water on site.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	LANDS AND DAMAGES RISKS								
LD-2	Structure Removal	No details for the structures to be removed.	The PDT noted that there is the possibility of commercial relocation. It is as good assumption that it is likely the scope for this item will increase. The impact is assumed to be marginal.	Very Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
LD-3	Land Acquisition	Land acquisitions and unwilling property owners. Stakeholder involvement.	This has the potential to change the project scope. Risk captured in the scope risk element.	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
LD-4	Utilities	sewer, telecommunications and road relocations may be applicable. Possible gas line on western edge of mainland.	There is one location near the new bridge where new or relocated utilities can be expected. This should be a small marginal cots.	Very Likely	Marginal	MODERATE	Unlikely	Marginal	LOW
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	REGULATORY AND ENVIRONMENTAL								
RE-2	Industrial Contamination	Possible prior industrial/agriculture activity and dumping.	David Clark Please Fill Out	Very Likely	Crisis	HIGH	Likely	Significant	HIGH
RE-5	Creosote Pilings	Risk that we will encounter creosote pilings the cost and effort to dispose	David Clark Please Fill Out	Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
RE-6	Cultural Resources	Extremely high probability for unidentified cultural resources to be found with in project area. Previously recorded archaeological sites and historic structures known to be located both in the project footprint and within close proximity. The majority of these resources remain unevaluated to the National Register of Historic Places. The cultural resources survey could identify additional cultural resources within the project footprint.	If any archaeological sites and/or historic structures (both known and unknown) are determined eligible to the National Register they must either be avoid or the adverse effect be mitigated. Unevaluated site/structures need to be evaluated for the National Register. Due the large number of currently known archaeological sites and historic structures and the possibility for additional resources to be identified by the cultural resource survey there is a concerns that avoidance may not be feasible in some situations and mitigation will need to occur. The project area will need to be surveyed and archaeological monitoring will likely be necessary during construction.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	CONSTRUCTION RISKS								
CON-1	Post-Levee Removal Flooding	Following levee removal work on filling ag ditches will occur. The site will be vulnerable to flooding at that point and there could be slow downs.	This is very unlikely to occur. Likely to affect schedule only	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW
CON-2	Construction Mods	There is always the risk for construction mods.	Earthwork projects often have differing site conditions that will make construction more challenging for the contractor. Typically no more than 10%.	Very Likely	Critical	HIGH	Likely	Significant	HIGH
CON-3	Bridge Placement	Construction methods may be different than what was assumed in the cost estimate	A different method of construction could affect the crew sizes and production rates and durations.	Very Likely	Significant	HIGH	Likely	Significant	HIGH
				Project Cost			Project Schedule		
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule		
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
	ESTIMATE AND SCHEDULE RISKS								
EST-1	Earthwork Quantities	See TL-1/2 Risk & Con-2	See TL-1/2 Risk & Con-2	Very Unlikely	Negligible	LOW	Very Likely	Negligible	LOW
EST-2	LWD & Plantings	The scope is very limited and quantities are broad	Scope and quantities are very likely to change since no known quantities.	Likely	Negligible	LOW	Likely	Negligible	LOW
EST-4	Bridge Cost Model	Used many cost book items. Used many assumptions	Cost book items and assumptions may not be entirely accurate or applicable to the project. It is likely there will be changes to cost model for the bridge as the design progresses. The impact could be significant given the % of costs for the numerous bridges to the TPC.	Very Likely	Significant	HIGH	Likely	Marginal	MODERATE
EST-5	Flooding and Work Windows	Project takes places over many years and there are likely to be weather issues, possible flooding, and other issues that occur during this time.	There is a high likelihood that there will be schedule impacts because of this. Cost impacts would be relatively marginal.	Unlikely	Marginal	LOW	Likely	Negligible	LOW
	ECONOMICS RISKS								
FL-1	Fuel	Fuel prices are volatile and will probably go up	A 25% increase in fuel could contribute to up to a 3% increase in total construction costs. How likely is it that gasoline will reach $5.00/gal? Depends on who you ask. For the purposes of this risk analysis, assume that it is unlikely.	Likely	Marginal	MODERATE	Very Unlikely	Negligible	LOW
FL-2	Asphalt	Asphalt is a petroleum product and subject to fluctuation.	Assume likely and marginal.	Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
FL-3	Concrete & Steel		Cost of steel and other metals are subject to market conditions. It is believed that there is at least a 50% chance of fluctuation upward. The impact is considered to increase the total project costs no more than 1%	Likely	Negligible	LOW	Very Unlikely	Negligible	LOW
	Programmatic Risks	(External Risk items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)							
PR-1	Changing Laws/Regulations	Laws, regulations, and guidelines could change over the life of the project, potentially requiring changes in materials used on sites, adjusted construction methodology, or increased design/study requirements.	In general this risk was viewed to be very unlikely to affect the project. The only exception is that the WA Dept. of Ecology may change its sediment management guidelines. However, these changes are not expected to require more than extremely minor adjustments to TPC.	Very Unlikely	Negligible	LOW	Very Likely	Negligible	LOW