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ENVIRONMENTAL CHECKLIST

Port of Seattle Bankline Repair and Enhancement Multi-site Program
Port of Seattle SEPA File #2019-01

PURPOSE

The State Environmental Policy Act (SEPA), Chapter 43.21 RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. The purpose of this checklist is to provide information to help identify impacts from the proposal (and to reduce or avoid impacts, if possible) and to help the Port of Seattle to make a SEPA threshold determination.

A. Background

1. Name of proposed project, if applicable:
Port of Seattle Bankline Repair and Enhancement Multi-site Program

2. Name of applicant:
Laura Wolfe, Port of Seattle, Senior Environmental Management Specialist

3. Address and phone number of applicant and contact person:
2711 Alaskan Way
Seattle, WA 98121
206-787-4292

4. Date checklist prepared:
12/20/2018

5. Agency requesting checklist:
Port of Seattle

6. Proposed timing or schedule (including phasing, if applicable):
This Program includes as-needed bankline repair and rehabilitation actions proposed to take place over the next 10 years, which is the duration of the associated US Army Corps permit. Most work below the Ordinary High Water Mark (OHWM) will occur during the approved Washington Department of Fish and Wildlife work windows. Work occurring above OHWM or with limited in-water disturbance may occur outside the work windows if conservation measures are followed.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.
The Port of Seattle (Port) has an ownership and/or management interest in over 15 miles of armored, urban-industrial shoreline which requires regular maintenance and repair to ensure stability. Such actions have been undertaken by the Port for over 100 years and will continue into the foreseeable future. In recent years, the Port has begun to include ecological enhancement as a component of its repair and maintenance activities.

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8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

1. Joint Aquatic Resources Permit Application (JARPA)
2. Biological Assessment (BA) to support Formal Endangered Species Act, Section 7 Consultation
3. Hydraulic Project Approval application
4. Underwater Noise Monitoring Plan
5. Mapbook of Port of Seattle shoreline conditions

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

Repair and enhancement activities are currently ongoing along the Port's banklines. This Program will provide a process to evaluate past work and identify future needs and enhancement potential.

10. List any government approvals or permits that will be needed for your proposal, if known.

1. Hydraulic Project Approval from Department of Fish and Wildlife
2. Clean Water Act, Individual Section 404/10 approval from US Army Corps of Engineers, including review by agencies/tribes as follows:
    - United States Fish & Wildlife Service (Endangered Species Act, Section 7 review of potential impacts on bull trout and marbled murrelet);
    - National Marine Fisheries Service/NOAA (Endangered Species Act, Section 7 review of potential impacts on Chinook salmon, Southern Resident killer whales, and humpback whales);
    - Environmental Protection Agency (review of compatibility with CERCLA-designated cleanup actions);
    - Washington State Department of Ecology (review of compatibility with MTCA-designated cleanup actions);
    - Washington State Department of Archaeology and Historic Preservation (Section 106 review of potential impacts on historic properties, archaeological resources, and cultural resources);
    - Muckleshoot Indian Tribe and Suquamish Tribe (review of potential impacts on treaty-reserved fish and shellfish resources).
3. Clean Water Act, Section 401 Water Quality Certification from Department of Ecology
4. Shoreline Master Program review by local jurisdictions (project-by-project basis)
5. Environmentally Critical Area review, if applicable (project-by-project basis)
6. Port of Seattle internal stormwater and grading review
7. National Pollution Discharge Elimination System Construction Stormwater General Permit, if applicable (project-by-project basis)

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The Port Bankline Repair and Enhancement Multi-site Program (Program) would establish a systematic process for enhancement of shoreline environmental functions while maintaining the structural integrity and stability of Port-controlled banklines. The Port routinely engages in bankline repair and maintenance activities along approximately 15.4 miles of Port-controlled shoreline facilities in the Seattle area. These activities have included in-kind replacement of existing hard stabilization materials, such as riprap and vertical bulkheads, as

well as enhancement with alternative stabilization techniques, such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques. In most cases, each of these past projects was permitted individually, resulting in duplicative efforts by the Port and regulatory agency staff.

The need for future bankline repair and maintenance activities will continue regardless of whether these activities are covered under programmatic or individual authorizations. Long-term programmatic authorizations provide a more efficient regulatory approach since they reduce redundancy, saving resources and time for both the Port and agencies, while avoiding and minimizing potential negative environmental effects. A programmatic approach also lends consistency and predictability across projects and allows the Port to leverage its considerable experience to maximize environmental improvements.

The Program does not allow the conversion of unarmored shoreline to an armored shoreline. The Program does not apply to expanded hard bankline stabilization structures and is strictly limited to repair and maintenance of existing structures. New structures, when needed, will be reviewed separately.

Program Components

Bankline Asset Condition Assessments. The first step in the programmatic process involves the identification of bankline areas that are actively failing or are at risk of imminent failure, i.e. require repair and maintenance actions. The Port will perform "asset condition assessments" on a regular schedule. Consistent with current shore-side facility practices, one-third of the Port's bankline facilities will be inventoried annually and maintenance needs will be identified. After three years, all of the Port's bankline facilities will be inventoried. This three-year maintenance inspection schedule will continue into the future.

Decision Process. Once at-risk or failing banklines are identified, a decision process will be used to select preferred repair and maintenance techniques. The Design Team will analyze and evaluate each project for repair options and potential for enhancement. The following disciplines comprise the Design Team: engineering; environment and sustainability, permitting and compliance, survey, erosion and sediment control, soil/sediment remediation, and geotechnical engineering. The Design Team will utilize the evaluation framework, or decision flowchart, to ensure compliance with local, state, and federal standards. The use of alternative stabilization techniques is prioritized over the use of hard armoring in the Bankline Decision Flowchart.

Typicals. Design typicals are intended to generally portray the range of shoreline stabilization types found at the Port properties. Each typical includes a cross-sectional view and associated description and example photographs. The typicals are organized into two categories, "hard stabilization" and "alternative stabilization", as described below. Depending on individual site characteristics, projects may incorporate a combination of both hard and alternative stabilization measures. Proposed outcomes for each type of bankline condition, including alternative stabilization measures, are presented graphically and described. Typicals are not intended to take the place of project-specific drawings, which will be submitted for review and concurrence prior to each project.

A. Hard Stabilization Typicals

1. Rubble-strewn Bank
2. Conventional Armored Slope
3. Step Wall Bulkhead
4. Sloped Bulkhead/Boat Ramp
5. Bulkhead and Conventional Armored Slope
6. Vertical Bulkhead

B. Alternative Stabilization Typicals

1. Top of Slope Riparian Buffer
2. On-slope Riparian Buffer
3. Transition Anchor System
4. Emergent Marsh Bed
5. Natural Beach
6. Intertidal or Subtidal Bench

Overwater structures, derelict piles, and debris may be present in conjunction with any of the shoreline treatments. The presence of an overwater structure may affect bankline repair and maintenance needs and associated designs appropriate for a given site. Removal of derelict piles or debris at or immediately waterward of the bankline repair and enhancement project is included in the proposed Program.

Conservation Measures. The Port has created a checklist of general and treatment-specific conservation measures that will help ensure that potential adverse effects resulting from the selected design treatment are avoided and minimized. A description of all conservation measures is included in the JARPA and BA.

Construction Sequence. The Generalized Construction Sequence describes the process that will be used before, during, and following construction to avoid and minimize potential environmental impacts and ensure environmental regulatory compliance. This construction sequence builds on many of the conservation measures to avoid and minimize impacts. It also includes a description of post-construction monitoring standards, methods, and schedule for different types of bankline treatments included in the Program.

Water Quality Monitoring and Protection A programmatic Water Quality Monitoring and Protection Plan (WQMPP) is proposed to address the range of potential projects. The Port's standard vigilance in preparation, planning, and response is proposed where work is entirely above the OHWM (Level 1). Where work extends below the OHWM, but is conducted entirely in the dry, or where in-water work requires limited disturbance, such as pile removal, visual monitoring for turbidity will be required in addition to standard practices for preparation, planning, and response (Level 2). Physical sampling is required for all other in-water work (Level 3), as described in the WQMPP.

Project Impact Tracking. The Port will track all project impacts using a dedicated Bankline Repair and Enhancement Program Ledger. The Port will use the Habitat Equivalency Analysis (HEA) model, modified to accommodate inputs relevant to this Program, to calculate potential changes in habitat condition for each individual bankline repair and maintenance project. Details of this approach are provided in "Tracking Impacts of Port Bankline Repair and Maintenance Projects Using Habitat Equivalency Analysis" (July 2018). The Port anticipates, given the focus on use of alternative stabilization techniques, that the ledger will document a significant increase in bankline habitat quality over time.

Program Compliance

Project Notification. The Port will transmit each project notification form to USACE, WDFW, Ecology, and the tribes at least 60 days prior to anticipated construction. The Port will use a Project Information Form similar to that utilized for the Pile Systems Repair and Maintenance Programmatic Permit. Details will include the following:

- Project location, size, and description
- Project Manager and applicant contact information
- Summary of existing conditions
- Summary of decision process to select preferred treatments

- Project-specific drawings, including temporary erosion and sediment control plan and stormwater pollution prevention plan, if applicable
- Selected conservation measures- including monitoring, if applicable
- Construction date and duration
- Pre- and post-HEA results
- Applicable water quality monitoring procedures per WQMPP

Concurrence Process. The Port will not proceed with the Project until it receives all necessary concurrence from USACE, WDFW, Ecology, DAHP, and the tribes, as stipulated by permit conditions. All bankline repair and enhancement activities conducted as part of this Program within CERCLA or MTCA designated cleanup sites will be coordinated with the EPA and/or Ecology and will be designed to not preclude or foreclose future cleanup options. All projects will also be subject to individual Shoreline Master Program compliance review by the local jurisdiction.

Construction Reporting. The Port will send notification of construction start and completion dates to all agencies and tribes as stipulated by permit conditions. Any and all additional construction or post-construction-related monitoring and reporting will be completed as stipulated in project conservation measures or conditions. A monitoring report or memorandum will be prepared in each monitoring year of the Program to provide a brief summary of conditions and any recommendations for further maintenance or repair necessary to meet performance standards.

Annual Reporting. The Port will provide an annual report, including a summary of the projects and the HEA ledger status for each calendar year.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The proposed programmatic activities will apply at the 29 Port-controlled shoreline facilities in the Seattle area. It will apply to properties along the Duwamish Waterway, including the East and West Waterways (EWW and WWW, respectively) in the Green/Duwamish Watershed (Water Resource Inventory Area [WRIA] 9); Puget Sound, including Elliot Bay in the Green/Duwamish Watershed (WRIA 9) and Shilshole Bay in the Cedar/Sammamish Watershed (WRIA 8); and the Lake Washington Ship Canal in the (WRIA 8). For the purposes of this Program, sites will be addressed in the following zones:

- Marine – Elliott Bay and Puget Sound
- Estuarine – Duwamish Waterway (including the EWW and WWW - River Miles 0.0 to 5.0)
- Freshwater – Lake Washington Ship Canal and Salmon Bay

Additional location details have been submitted as part of the JARPA Application and BA.

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B. Environmental Elements

1. *Earth*

a. General description of the site:

(circle one): Flat, rolling, hilly, steep slopes, mountainous, other _____

All projects are proposed on existing banklines, ranging from vertical bulkheads to natural beaches.

b. What is the steepest slope on the site (approximate percent slope)?

The steepest slope on the site is a vertical bulkhead.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Soils on site are generally industrial fill and alluvial layers. There is no agricultural land of long-term commercial significance along the Port shoreline.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

Seattle is situated in a moderately active earthquake region where the Juan de Fuca plate is thrust beneath the North American plate along the toe of the continental slope (Galster and Laprade, August 1991). The Uniform Building Code (1997 Edition) places the Puget Sound area within Seismic Zone 3, which indicates significant seismic risk. The design level earthquake for this zone is magnitude 7.0 to 7.5 with peak ground acceleration of about 0.3g.

Most Port facilities are in liquefaction zones. Since the Program is focused on repair and maintenance of existing shoreline revetment structures, there will be evidence of erosion, structural decline, and slope failure in the project areas. The repair and enhancement activities are expected to improve slope stability and ecological functions.

e. **Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.**

The Port is beginning a program that will expand its existing inventory of maintenance needs for Port facilities to include bankline conditions in an asset condition assessment. One-third of the Port's bankline facilities will be inventoried annually and maintenance needs will be identified. After three years, all of the Port's bankline facilities will have been inventoried. This three-year assessment schedule will continue into the future. Because this program has just begun, the extent of the Port's bankline maintenance needs has not been specifically determined. Nevertheless, the Port submits that regular repair and maintenance is essential to operations and safety and anticipates that up to 20 percent of its banklines will require repair and maintenance over the next 10 years.

The Port anticipates that derelict pile removal under the Program would be a relatively infrequent occurrence. Derelict piles that occur at or immediately waterward of Port-controlled banklines are typically less than 24 inches in diameter and made of wood, which is often creosote-treated. Occasional smaller diameter steel piles also may be encountered and removed under this Program.

The Program does not allow the conversion of unarmored shoreline to an armored shoreline. The Program does not apply to expanded hard bankline stabilization structures and is strictly limited to repair and maintenance of existing structures. New structures, when needed, will be reviewed separately.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

A minor amount of erosion is possible due to excavation and fill activities associated with slope construction. The JARPA and BA outline general construction sequence and conservation measures to reduce potential erosion sources. Erosion and Sediment Control Plans and Construction Stormwater Pollution Prevention Plans will be created when applicable. Work will be conducted in the dry if possible and within the in-water work windows if applicable.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Repair and enhancement activities will either result in the same amount of impervious surface (in-kind replacement) or reduce the current amount of impervious surface (alternative stabilization) on banklines.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

The JARPA and BA outline general construction sequence and conservation measures to reduce potential erosion sources. Erosion and Sediment Control Plans and Construction Stormwater Pollution Prevention Plans will be created when applicable. Work will be conducted in the dry if possible and within the in-water work windows if applicable. Specific conservation measures include:

- Maintain Temporary Erosion and Sediment Control Plan onsite
- Confine construction impacts to the minimum area necessary, delineate impacts on project plans and onsite.
- Establish staging and site access areas along existing roadways or other disturbed areas
- Limit clearing and grubbing areas to minimum required, retain vegetation to maximum extent
- Use sediment barriers to prevent erosion and sediment from entering waterbodies
- Keep erosion control materials onsite to respond to emergencies
- Use curb inlet sediment traps and geotextile filters to capture sediment before it leaves the site
- Locate equipment wash areas where washwater, sediment, and pollutants cannot enter waterbodies

- Do not track sediment onto paved streets or roadways
- Remove equipment and excess supplies, clean work storage areas, and remove temporary erosion control materials and temporary fill after construction and when soils have stabilized
- Install erosion and water quality control devices prior to beginning of work

2. Air

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Construction activities may create short-term, intermittent increases in dust and emissions. These effects will be temporary in duration, minimal in nature, and limited to the immediate construction equipment and activities. No significant air quality impacts are anticipated as a result of the Program.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site sources of emissions or odor that affect the proposal.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

All construction equipment will be maintained in proper working order and within compliance with State regulations for vehicle emissions. During construction, the site will be watered as necessary to reduce fugitive dust emissions.

3. Water

a. Surface Water:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The proposed Program will apply at the 29 Port-controlled shoreline facilities in the Seattle area. It will apply to properties along the Duwamish Waterway, including the East and West Waterways (EWW and WWW, respectively) in the Green/Duwamish Watershed (Water Resource Inventory Area [WRIA] 9); Puget Sound, including Elliot Bay in the Green/Duwamish Watershed (WRIA 9) and Shilshole Bay in the Cedar/Sammamish Watershed (WRIA 8); and the Lake Washington Ship Canal in the (WRIA 8). For the purposes of the Program, sites will be addressed in the following zones:

- Marine – Elliott Bay and Puget Sound
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2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

The Port routinely engages in bankline repair and maintenance activities along approximately 15.4 miles of Port-controlled shoreline facilities. These activities have included in-kind replacement of existing hard stabilization materials, such as riprap and vertical bulkheads, as well as enhancement with alternative stabilization techniques such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques. In most cases, each of these past projects was permitted individually, resulting in duplicative effort by the Port and regulatory agency staff. Such activities are included in this Program

The Program does not allow the conversion of unarmored shoreline to an armored shoreline. The Program does not apply to expanded hard bankline stabilization structures and is strictly limited to repair and maintenance of existing structures. New structures, when needed, will be reviewed separately.

The JARPA application includes a process in which the Port will assess existing banklines and identify potential repair and enhancement opportunities. In determining preferred post-project conditions, the Design Team will work through the decision flowchart described above, considering first those designs that represent improved habitat function compared with existing bankline conditions. As a result, bankline conditions across Port properties will improve in environmental function over time. Port staff will document the area-wide functional habitat improvements over the course of the repair and maintenance Program. Additional details are included in the JARPA application.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

The Port is beginning a program that will expand its existing inventory of maintenance needs for Port facilities to include bankline conditions in an asset condition assessment. One-third of the Port's bankline facilities will be inventoried annually and maintenance needs will be identified. After three years, all of the Port's bankline facilities will have been inventoried. This three-year assessment schedule will continue into the future. Because this program has just begun, the extent of the Port's bankline maintenance needs has not been specifically determined. Nevertheless, the Port submits that regular repair and maintenance is essential to operations and safety and anticipates that up to 20 percent of its banklines will require repair and maintenance over the next 10 years.

The Port anticipates that derelict pile removal under the Program will be a relatively infrequent occurrence. Derelict piles that occur at or immediately waterward of Port-controlled banklines are typically less than 24 inches in diameter and made of wood, which is often creosote-treated. Occasional smaller diameter steel piles also may be encountered and removed under this Program.

This application is for repair, maintenance, or enhancement only and will not change or expand existing uses. Projects are not expected to adversely impact vegetation and habitat conditions on subject properties, and similarly, adverse permanent wetland or water impacts are not expected. If a project did necessitate adverse wetland or water impacts, authorization would not be sought under the Program. Rather, an individual project specific application would be submitted along with appropriate mitigation plans.

Project specific drawings, submitted for review prior to each project, will identify any wetlands or waters located within the project area. Documentation of how the project avoids adverse wetland and water impacts will be provided when applicable.

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In addition to compliance with all environmental protection requirements of regulatory agencies, a Conservation Measure checklist has been created to identify standard conservation practices applicable to bankline repair and enhancement at the Port of Seattle properties. The checklist is submitted along with the JARPA.

A completed checklist will be submitted prior to construction for each project proposed under the Multi-site Program. A written justification for any applicable measures the project does not meet will accompany the checklist submittal.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

The Port does not anticipate any surface water withdrawals or diversions as a result of the proposed repair and enhancement activities.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

Bankline repair and enhancement activities will occur within the 100-year floodplain along Port-controlled facilities. See Section 3a for details.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The Bankline Repair and Enhancement Multi-site Program does not propose any discharges of waste materials to surface waters.

b. Ground Water:

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

Groundwater will not be withdrawn from a well for drinking water or other purposes.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals. . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

No waste material will be discharged into the ground or other sources as part of the proposed projects.

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c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

There will be no measurable change in rain runoff due to the proposed repair and enhancement activities. Proposed projects may decrease impervious surface and allow for additional infiltration. A minor amount of erosion is possible due to any slope regrading efforts during construction.

The JARPA and BA outline general construction sequence and conservation measures to reduce potential construction erosion sources. Erosion and Sediment Control Plans and Construction Stormwater Pollution Prevention Plans will be created when applicable. Work will be conducted in the dry if possible and within the in-water work windows if applicable.

2) Could waste materials enter ground or surface waters? If so, generally describe.

An equipment failure has the potential to spill fluids or diesel onto the ground or into the adjacent waterbody. The contractor will be required to prepare and implement a Spill Prevention, Control, and Countermeasures Plan.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

The proposed repair and enhancement activities could alter drainage patterns by allowing additional infiltration into the bankline prior to discharge into the closest waterbody.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

See Section 1h for erosion and sediment control measures and conservation measures.

4. Plants

a. Check the types of vegetation found on the site:

__X__deciduous tree: alder, maple, aspen, other
__X__evergreen tree: fir, cedar, pine, other
__X__shrubs
__X__grass
____pasture
____crop or grain
____ Orchards, vineyards or other permanent crops.
____ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
__X__other types of vegetation

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b. What kind and amount of vegetation will be removed or altered?

Bankline enhancement and rehabilitation activities will occur generally within highly-modified maritime industrial sites and urban waterways. Vegetation and habitat descriptions are included in the Biological Assessment prepared to accompany the JARPA. This application is for repair, maintenance, or enhancement only and will not adversely impact vegetation and habitat conditions on subject properties.

Alternative stabilization will be implemented through regrading of banks, placement and anchoring of large woody debris, removal/management of invasive weeds, topsoil amendment, or import and planting of native vegetation. Any new vegetation will be monitored for success as part of the Program.

c. List threatened and endangered species known to be on or near the site.

There are no known threatened or endangered plant species known to be on or near the site.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Details on landscaping per potential treatment type are included in the JARPA typicals. This application is for repair, maintenance, or enhancement only and will not adversely impact vegetation and habitat conditions on subject properties. Alternative stabilization will be implemented through regrading of banks, placement and anchoring of large woody debris, removal/ management of invasive weeds, topsoil amendment, or import and planting of native vegetation. Any new vegetation will be monitored for success as part of the Program.

e. List all noxious weeds and invasive species known to be on or near the site.

Himalayan blackberry and Japanese knotweed are known to occur in some locations in the Program area.

5. Animals

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: hawk, heron, eagle, songbirds, other: *waterfowl*
mammals: deer, bear, elk, beaver, other: *sea lions, harbor seals*
fish: bass, salmon, trout, herring, shellfish, other _____

b. List any threatened and endangered species known to be on or near the site.

Federally-listed species whose geographic range extends into at least a portion of the Action Area are identified in below. Additional details are located in the BA.

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Federally listed species whose range extends into the Action Area

Species	Federal Status	Action Areas	Critical Habitat Within Action Area
Puget Sound Chinook salmon *Oncorhynchus tshawytscha*	Threatened	All areas	All areas waterward of OHW or MHHW
Puget Sound steelhead *Oncorhynchus mykiss*	Threatened	All areas	All areas waterward of OHW along the Lower Duwamish River
Coastal-Puget Sound bull trout *Salvelinus confluentus*	Threatened	All areas	All areas waterward of OHW or MHHW
Killer whale: Southern Resident *Orcinus orca*	Endangered	Marine only	All waters in Puget Sound deeper than 20 ft (6.1 m)
Humpback whale *Megaptera novaeangliae*	Endangered (Central America), Threatened (Mexico)	Marine only	No critical habitat has been designated for the humpback whale
Marbled murrelet *Brachyramphus marmoratus*	Threatened	Marine only	No critical habitat designated within the action areas. Marine environments were not designated.
Eulachon *Thaleichthys pacificus*	Threatened	Marine only	No critical habitat designated within the action areas.
Bocaccio *Sebastes paucispinis*	Endangered	Marine/Estuarine only	Nearshore and deepwater habitat
Yelloweye rockfish *Sebastes ruberrimus*	Threatened	Marine only	Deepwater habitat (>30 m)

c. Is the site part of a migration route? If so, explain.

The Puget Sound area is part of the Pacific Flyway. Birds that inhabit the area vary seasonally due to migrations. Port facilities also are located on significant migratory routes for anadromous fish.

d. Proposed measures to preserve or enhance wildlife, if any:

The intent of the Bankline Repair and Enhancement Multi-site Program is to enhance existing Port banklines during repair and maintenance activities. The decision tree process points design to alternative stabilization techniques, including habitat creation. Additional measures to enhance habitat and protect species during construction are outlined in the BA.

Conservation measures and in-water work windows will be ascribed on a project-by-project basis. Work will be conducted in the dry if possible. Water quality, marine mammal monitoring, and vegetation monitoring plans will be followed as outlined in the BA.

e. List any invasive animal species known to be on or near the site.

No significant amounts of invasive animal species have been noted along the bankline repair areas.

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6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

The proposed repair and enhancement activities do not require energy as part of the completed project.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The projects will be located on existing banklines. Therefore, they will not affect the potential use of solar energy by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

There are no energy impacts, so no energy conservation features are included as part of the proposed project.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

There are no environmental health hazards that could occur due to the proposed projects. Potential hazards during construction are listed below.

1) Describe any known or possible contamination at the site from present or past uses.

All Port of Seattle facilities share historical maritime industrial land uses. The Port has been a central component of the Puget Sound region for a century and the Port has been a leader in balancing economic development with environmental stewardship and social responsibility. Port maritime facilities are home to international container terminals, large marinas, a world-class fishing fleet, and state-of-the-art cruise ship terminals.

All bankline rehabilitation and enhancement activities conducted as part of this Program within CERCLA or MTCA designated cleanup sites will be coordinated with the EPA and/or Ecology and will be designed to not preclude or foreclose future cleanup options. The following locations would need EPA and/or Ecology concurrence prior to project approval:

- T91
- T18
- North end of T5 and Pier 2
- T10
- All properties along the Duwamish Waterway
- All properties along the East Waterway

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

If there are any underground hazardous liquid or gas transmission lines near a proposed bankline repair or enhancement project, the lines will be managed as a constraint within the decision tree flowchart.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

There is a small risk of accidental spillage of fuels, oils, and /or hydraulic fluids associated with operation of dredging equipment for the few days that dredging would occur. Use of standard construction practices and the requirement for the contractor to comply with the Port's spill prevention and response procedures are expected to acceptably minimize this risk.

4) Describe special emergency services that might be required.

No special emergency services are required due to proposed repair and enhancement projects.

5) Proposed measures to reduce or control environmental health hazards, if any:

MTCA and CERCLA concurrence are required for projects located on contaminated properties. The contractor will be required to comply with the Port's spill prevention and response procedures are expected to acceptably minimize this risk.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

There are no noise sources which will affect the proposed bankline repair and enhancement activities.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

There will be short-term, temporary noise impacts due to construction equipment on the project areas. The projects are anticipated to be relatively small in nature and not result in a large amount of truck trips. Work will occur during normal work hours and will comply with local noise ordinance. If nighttime construction occurs and is anticipated that it will exceed the limits of the local noise ordinance, then the Port would be required to obtain a variance for the evening work period.

Upon project completion, noise levels will return to pre-project levels.

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3) Proposed measures to reduce or control noise impacts, if any:

The Port of Seattle will adhere to all applicable federal, state, and local noise regulations governing construction activities.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

Bankline repair and enhancement activities will occur on Port of Seattle properties that are primarily committed to maritime industrial, cargo, cruise, recreational and commercial moorage, and other water-dependent or water-related commercial uses. This application is for repair and enhancement of existing structures and does not propose to change or expand existing uses. The project may include the conversion of some adjacent upland areas to bankline habitat. The overall land uses on nearby or adjacent properties will not be affected. Repair and enhancement activities will be submitted to the local jurisdiction for review on a project-by-project basis.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?

The project sites have not been used as working farmlands or forest lands.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:

Bankline enhancement and rehabilitation activities will occur generally within highly-modified maritime industrial sites and urban waterways. The Program will not affect or be affected by a working farm or forestland.

c. Describe any structures on the site.

The Port's facilities include a wide range of structural amenities. Bankline areas, which are the focus of this application, can have various structures supporting water-dependent uses, such as vertical bulkheads, riprap, sheet pile walls, piers, and fendering systems.

d. Will any structures be demolished? If so, what?

Some bankline enhancement projects may result in the conversion of hard stabilization to alternative stabilization. This may require the removal of riprap, piles, sheetpile, bulkhead, or any additional structures along the top of the bankline (pavement, fence, etc.).

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e. What is the current zoning classification of the site?

Port banklines from SDCI GIS are zoned industrial commercial, general industrial and downtown harborfront.

f. What is the current comprehensive plan designation of the site?

The City of Seattle 2035 Comprehensive Plan, where most Port properties are located, has Port properties designated as commercial/mixed use areas, manufacturing/industrial center, and urban center.

g. If applicable, what is the current shoreline master program designation of the site?

Shoreline designations from Seattle Department of Construction and Inspection GIS include urban maritime, urban commercial, urban industrial, conservancy management, conservancy recreation, conservancy preservation, and urban Harborfront.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

Most Port facilities are in liquefaction zones and have steep slope areas, flood prone areas, and are adjacent to aquatic wildlife habitat.

i. Approximately how many people would reside or work in the completed project?

People would not reside or work in the completed project areas.

j. Approximately how many people would the completed project displace?

The completed projects would not displace any people.

k. Proposed measures to avoid or reduce displacement impacts, if any:

There will be no displacements.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The Program allows for the repair and enhancement of existing Port banklines. The proposed projects will not impact existing or projected land uses. Repairs and enhancement activities will be submitted to the local jurisdiction for review on a project-by-project basis.

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m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:

The Program allows for the repair and enhancement of existing Port banklines. The proposed projects will not impact agricultural or forest lands.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

No housing will be provided as part of this Program.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

No housing will be eliminated as part of this Program.

c. Proposed measures to reduce or control housing impacts, if any:

The Program allows for the repair and enhancement of existing Port banklines. The proposed projects will not impact housing.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Proposed bankline repair and enhancement treatments can include hard stabilization materials, such as riprap and vertical bulkheads, and alternative stabilization techniques, such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques. Any hard stabilization will most likely be less than four feet above the bankline. Vegetation could be various heights above the finished bankline.

b. What views in the immediate vicinity would be altered or obstructed?

The Program will either replace existing bankline treatments in-kind, or offer a softer shoreline treatment, adding relief to the existing shoreline. No views are expected to be altered or obstructed due to the bankline repair and enhancement treatments.

c. Proposed measures to reduce or control aesthetic impacts, if any:

There are no expected aesthetic impacts due to this project. The proposed Program is expected to soften existing shoreline structures where possible, providing additional aesthetic enjoyment of existing Port facilities.

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11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

No light or glare will be produced by the proposed repair and enhancement projects.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No light or glare will be produced by the proposed repair and enhancement projects.

c. What existing off-site sources of light or glare may affect your proposal?

Existing sources of light and glare will not affect the proposed repair and enhancement projects.

d. Proposed measures to reduce or control light and glare impacts, if any:

No light or glare will be produced by the proposed repair and enhancement projects.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

Port facilities include numerous parks and public access sites, such as those located at T-108, Turning Basin 3, T5, T18, Pier 69, South Riverside Drive, T86 Centennial Park, Jack Block Park, Jack Perry Memorial Shoreline, T-105 Public Park, T-107 Public Park, and South Park 8th Avenue South.

b. Would the proposed project displace any existing recreational uses? If so, describe.

The proposed repair and enhancement projects may result in temporary access constraints and noise impacts during construction. The Port provides temporary access and public safety plans for projects that plan to close trails or accessways due to construction activities.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Impacts to public access and recreation will be short-term and temporary in nature. There will be no permanent impact recreation opportunities. The proposed Program is expected to soften existing shoreline structures where possible, providing additional aesthetic enjoyment of existing Port facilities.

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13. Historic and cultural preservation

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers ? If so, specifically describe.

There are numerous buildings over 45 years of age on Port properties. The proposed repair and enhancement activities are not expected to impact any building of historical significance.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

Port facilities are built in industrial areas, mostly over and within historic fill. Evidence of historic occupation has been found on T-107, as documented in the following report:

Jermann, Jerry V., Thomas H. Lorenz, and Robert S. Thomas. 1977. *Continued Archeological Testing at the Duwamish No. 1 Site (45KI23)*. Office of Public Archaeology Institute for Environmental Studies, University of Washington, Reconnaissance Reports No. 11. March.

Waters in the vicinity of most Port facilities are Treaty-protected "usual and accustomed" fishing areas. Fishing activities are managed by the Suquamish Tribe and Muckleshoot Indian Tribe. Fishing by Tribe members in these areas is consistent with past federal government treaties and subsequent federal court decisions.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

The Port has consulted environmental conditions reports prepared for the Port, as well as the Washington Information System for Architectural & Archaeological Records Data. Tribes will be consulted on a project-by-project basis as part of the Program's permit conditions.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

The projects performed under the proposed Program are repair and enhancement of existing banklines. Project may include some to no excavation. Tribes will be consulted on a project-by-project basis as part of the Program permit conditions. Any potential resources found during will result in a construction stop-work order.

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14. Transportation

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

The proposed projects will not alter existing access to the street system.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

Some Port facilities are currently served by public transit. The proposed projects will not alter or impact demand on existing public transit systems.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

The proposed Program will not create additional parking and is not expected to eliminate any parking that is currently in use.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

The proposed bankline repair and enhancement projects will not require any new or improvements to existing roads, streets, pedestrian, bicycle, or state transportation facilities. The bankline repairs could require the temporary closure of public access sites or realignment of trails along existing Port banklines. These impacts will be short-term and temporary in nature. Trail work will be submitted to the local jurisdiction for review on a project-by-project basis.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The proposed repair and enhancement activities will not use water, rail, or air transportation.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?

No vehicle trips will be generated by the completed repair and enhancement projects.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

The proposed repair and enhancement activities will not interfere with or be affected by the movement of agricultural and forest products.

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h. Proposed measures to reduce or control transportation impacts, if any:

There are no transportation impacts expected as a result of the proposed repair and enhancement activities.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

The proposed repair and enhancement activities will not increase the need for public services.

b. Proposed measures to reduce or control direct impacts on public services, if any.

The proposed repair and enhancement activities will not impact public services.

16. Utilities

a. Circle utilities currently available at the site:
electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system,
other _____

a. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The proposed repair and enhancement activities do not require utilities. Utilities could be relocated as part of a proposed project. If there are any utility lines near a proposed bankline repair or enhancement project, the lines will be managed as a constraint within the decision tree flowchart.

C. Signature

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Laura Wolfe

Name of signee Laura D. Wolfe, AICP

Position and Agency/Organization Sr. Environmental Management Specialist, Port of Seattle

Date Submitted: 1/14/2019

Biological Assessment

Port of Seattle Bankline Repair and Enhancement Multi-site Program

NWS-2018-780-WRD

Seattle, Washington

Prepared for:

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Seattle District – Regulatory Branch
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Biological Assessment for the Port of Seattle Bankline Repair and Enhancement Multi-site Program NWS-2018-780-WRD

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Acronyms and Abbreviations

BA	Biological Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DSAY	Discounted Service Acre Years
EFH	Essential Fish Habitat
ESA	Endangered Species Act
EWW	East Waterway
FMP	Fisheries Management Plan
HEA	Habitat Equivalency Analysis
IPaC	Information for Planning and Conservation
LDR	Lower Duwamish River
MHHW	Mean Higher High Water

MLLW	Mean Lower Low Water
MTCA	Model Toxics Control Act
NMFS	National Marine Fisheries Service
OHWM	Ordinary High Water Mark
PCE	Primary Constituent Elements
SR	Southern Resident
USFWS	U.S. Fish and Wildlife Service
WRIA	Water Resource Inventory Area
WWW	West Waterway

Section 1. Introduction

This Biological Assessment (BA) is prepared as a regulatory requirement for the project in compliance with the Endangered Species Act (ESA). All federal agencies are required to consult with the U.S. Fish and Wildlife (USFWS) and the National Marine Fisheries Service (NMFS) in accordance with Section 7(a)(2) of the ESA regarding potential effects to federally listed or proposed species. The federal agency that is initiating, authorizing, or funding the "action" in question must ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a federally listed threatened or endangered species, or a species proposed to be listed, or result in the destruction or adverse modification of designated or proposed critical habitat.

Essential Fish Habitat (EFH) is identified in the project Action Area; therefore, an EFH analysis will also be included in compliance with the Magnuson-Stevens Act of 1996, which requires federal agencies to consult with NMFS whenever a proposed project has the potential to adversely affect EFH.

1.1 Project Proponent and Federal Nexus

The Port of Seattle (Port) is the project proponent. Federal permitting through the U.S. Army Corps of Engineers (Corps) under Section 404 of the Clean Water Act and Section 10 Rivers and Harbors Act provides the federal nexus for consultation under the ESA.

1.2 Project Purpose

The Port Bankline Repair and Enhancement Multi-site Program will establish a systematic process for enhancement of shoreline environmental functions while maintaining the structural integrity and stability of Port-controlled banklines. Specifically, the program will maintain and improve the following functions:

- Shoreline environmental functions, including improvement of riparian and aquatic habitat, enhancement of water quality, and improvement of bankline resilience;
- Protection of Port facilities from slope failure, structural decline and other degradation; and
- Public shoreline access to publicly-owned shorelines and open space.

1.3 Project Location and Setting

The proposed programmatic activity will apply at the 29 Port-controlled shoreline facilities in the Seattle area (Figure 1). It will apply to properties along the Duwamish Waterway, including the East and West Waterways (EWW and WWW, respectively) in the Green/Duwamish Watershed (Water Resource Inventory Area [WRIA] 9); Puget Sound, including Elliot Bay in the

Green/Duwamish Watershed (WRIA 9) and Shilshole Bay in the Cedar/Sammamish Watershed (WRIA 8); and the Lake Washington Ship Canal in the (WRIA 8). For the purposes of this programmatic permit, sites will be addressed in the following zones:

- Marine – Elliott Bay and Puget Sound
- Estuarine – Duwamish Waterway (including the EWW and WWW - River Miles 0.0 to 5.0)
- Freshwater – Lake Washington Ship Canal and Salmon Bay

1.4 Consultation History

The Port routinely engages in bankline repair and maintenance activities at the 29 Port-controlled shoreline facilities. These activities have included in-kind replacement of existing hard stabilization materials, such as riprap and vertical bulkheads, as well as enhancement with alternative stabilization techniques such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques.. In most cases, each of these projects has received individual review and consultation under the ESA.

Port staff met with state and federal permit agency staff on August 9, 2018 to develop the scope of this project application. Agency staff in attendance included Frank Nichols, from the Corps, Jim Muck, from the USFWS, and Shandra O'Haleck and Jeff Vanderpham from the NMFS.

1.5 Study Methods

This BA relies on review of available information on species presence and distribution based on review of the following sources:

- USFWS Information for Planning and Consultation (IPaC) website (https://ecos.fws.gov/ipac/)
- ESA listings and critical habitat designations,
- Site-based information, and
- Seattle Biological Evaluation.

On May 7, 2018, staff from The Watershed Company and the Port conducted site-level reconnaissance visits to document current conditions and the range of bankline repair and enhancement efforts implemented by the Port.

Together, information on species occurrence and distribution, the environmental setting, and the nature of proposed effects were used to determine the likelihood of potential effects to federally listed species.

Section 2. Proposed Action

2.1 Description of the Proposed Action

The Port Bankline Repair and Enhancement Multi-site Program (Program) would establish a systematic process for enhancement of shoreline environmental functions while maintaining the structural integrity and stability of Port-controlled banklines. The Program will apply only to repair and enhancement of existing bankline stabilization or to enhancement of ecological functions. Actions may also include replacement of sheetpile or occasional removal of derelict piles at or immediately waterward of the bankline. For the purposes of this permit, boat ramps are considered equivalent to sloped bulkheads, and they may be repaired or replaced under this permit.

2.1.1 Projected Length of Bankline Repair and Maintenance by Type of Bankline

A map collection (Mapbook) of the Port-controlled shoreline facilities identifies existing bankline conditions to illustrate the range of existing conditions (Attachment F). The first page of the Mapbook presents a summary of bankline conditions in terms of linear feet and percentage of total Port bankline. The Port is beginning a program that will expand its existing inventory of maintenance needs for Port facilities to include bankline conditions in an asset condition assessment. One-third of the Port's bankline facilities will be inventoried annually and maintenance needs will be identified. After three years, all of the Port's bankline facilities will have been inventoried. This three-year assessment schedule will continue into the future. Because this program has just begun, the extent of the Port's bankline maintenance needs has not been specifically determined. Nevertheless, the Port submits that regular repair and maintenance is essential to operations and safety and anticipates that up to 20 percent of its banklines will require repair and maintenance over the next 10 years. Table 1 describes the length of bankline repair based on the existing bankline type.

The Port anticipates that derelict pile removal under this programmatic permit would be a relatively infrequent occurrence. Derelict piles that occur at or immediately waterward of Port-controlled banklines are typically less than 24 inches in diameter and made of wood, which is often creosote-treated. Occasional smaller diameter steel piles also may be encountered and removed under this programmatic permit.

Table 1. Length of bankline repair and maintenance anticipated over a 10-year period (lineal feet) categorized by existing condition

Zone	Length of bankline repair and maintenance anticipated over a 10-year period (lineal feet)									
	Vertical bulkhead	Bulkhead and conventional armored slope	Sloped bulkhead/ boat ramp	Step wall bulkhead	Conventional armored slope	Rubble-strewn slope	Alternative stabilization with riparian	Marsh	Natural beach	Total length
Marine	119	4,514	0	89	2,320	28	0	0	143	7,213
Estuarine	205	3,493	41	117	2,446	249	145	850	624	8,170
Freshwater	865	0	58	0	0	0	7	0	0	930
Total	**1,188**	**8,006**	**99**	**206**	**4,766**	**277**	**152**	**850**	**767**	**16,312**

The Port routinely engages in bankline repair and maintenance activities along approximately 15.4 miles of Port-controlled shoreline facilities. These activities have included in-kind replacement of existing hard stabilization materials, such as riprap and vertical bulkheads, as well as enhancement with alternative stabilization techniques such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques. In most cases, each of these past projects was permitted individually, resulting in duplicative effort by the Port and regulatory agency staff. Such activities are included in this program.

The need for future bankline repair and maintenance activities will continue regardless of whether these activities are covered under programmatic or individual authorizations. Long-term programmatic authorizations provide a more efficient regulatory approach since they reduce redundancy, saving resources and time for both the Port and agencies, while avoiding and minimizing potential negative environmental effects. A programmatic approach also lends consistency across projects and allows the Port to leverage its considerable experience to maximize environmental improvements.

The Program does not allow the conversion of unarmored shoreline to an armored shoreline. The program does not apply to expanded hard bankline stabilization structures and is strictly limited to repair and maintenance of existing structures. New structures, when needed, will be reviewed separately.

2.1.2 Program Components

Bankline Asset Condition Assessments

The first step in the programmatic process involves the identification of bankline areas that are at risk of failure, i.e. require repair and maintenance actions. The Port will perform "asset condition assessments" on a regular schedule. One-third of the Port's bankline facilities will be inventoried annually and maintenance needs will be identified. After three years, all of the Port's bankline facilities will be inventoried. This three-year maintenance inspection schedule will continue into the future.

Decision Process

Once at-risk or failing banklines are identified, a decision process will be used to select preferred repair and maintenance techniques. The Design Team will analyze and evaluate each project for repair options and potential for enhancement, ranging from in-kind replacement of hard armoring materials to replacement with alternative techniques. The following disciplines comprise the Design Team: engineering; environment and sustainability, permitting and compliance, survey, erosion and sediment control, soil/sediment remediation, and geotechnical engineering. The Design Team will utilize the Bankline Decision Flowchart (see Attachment A), to ensure compliance with local, state, and federal standards. The use of alternative stabilization techniques is prioritized over the use of hard armoring in the Bankline Decision Flowchart.

Typicals

Design typicals are intended to generally describe the range of shoreline stabilization types found at the Port properties, as well as the range of potential project outcomes. Each typical includes a cross-sectional view and associated description and example photographs. The typicals are organized into two categories, "hard stabilization" and "alternative stabilization", as listed below and as drawn and described in Attachment B. Depending on individual site characteristics, projects may incorporate a combination of both hard and alternative stabilization measures. Proposed outcomes for each type of bankline condition, including alternative stabilization measures, are presented graphically and described. Typicals are not intended to take the place of project-specific drawings, which will be submitted for review and concurrence prior to each project.

A. Hard Stabilization Typicals

1. Rubble-strewn Bank
2. Conventional Armored Slope
3. Step Wall Bulkhead
4. Sloped Bulkhead/Boat Ramp

5. Bulkhead and Conventional Armored Slope
6. Vertical Bulkhead

B. Alternative Stabilization Typicals

1. Top of Slope Riparian Buffer
2. On-slope Riparian Buffer
3. Transition Anchor System
4. Emergent Marsh Bed
5. Natural Beach
6. Intertidal or Subtidal Bench

Overwater structures, derelict piles, and debris may be present in conjunction with any of the shoreline treatments. The presence of an overwater structure may affect bankline repair and maintenance needs and associated designs appropriate for a given site. Removal of derelict piles or debris at or immediately waterward of the bankline repair and enhancement project is included in the proposed program.

Conservation Measures

The Port has created a checklist of general and treatment-specific conservation measures that will help ensure that potential adverse effects resulting from the selected design treatment are avoided and minimized. A description of all conservation measures is included in Attachment C.

Construction Sequence

The Generalized Construction Sequence (Attachment D) describes the process that will be used before, during, and following construction to avoid and minimize potential environmental impacts and ensure environmental regulatory compliance. This construction sequence builds on many of the conservation measures in Attachment C to avoid and minimize impacts. It also includes a description of post-construction monitoring standards, methods and schedule for different types of bankline treatments included in the program.

Water Quality Monitoring and Protection Plan

A programmatic Water Quality Monitoring and Protection Plan (WQMPP) is proposed to address the range of potential projects. The Port's standard vigilance in preparation, planning, and response is proposed where work is entirely above the OHWM (Level 1). Where work extends below the OHWM, but is conducted entirely in the dry, or where in-water work requires limited disturbance, such as pile removal, visual monitoring for turbidity will be required in addition to standard practices for preparation, planning, and response (Level 2).

Physical sampling is required for all other in-water work (Level 3), as described in the WQMPP (Attachment E).

Project Impact Tracking

The Port will track all project impacts using a dedicated Bankline Repair and Enhancement Program Ledger. The Port will use the Habitat Equivalency Analysis (HEA) model, modified to accommodate inputs relevant to this program, to calculate potential changes in habitat condition for each individual bankline repair and maintenance project. Details of this approach are provided below and in "Tracking Impacts of Port Bankline Repair and Maintenance Projects Using Habitat Equivalency Analysis" (July 2018). The Port anticipates, given the focus on use of alternative stabilization techniques, that the ledger will document a significant increase in bankline habitat quality over time.

HEA Model

The HEA model is an analytical tool designed to estimate changes in ecological services resulting from a project action. Inputs to the HEA model include the type and quantity of habitat or land cover being affected and the duration of the project action. It can be used to evaluate the benefits of a habitat restoration project, as well as the adverse impacts of a development project.

The unit of measure used in the model is a discounted service acre-year (dSAY), which quantifies the ecological service provided by an area (acres) over a specific length of time (in years). Discounting incorporates the standard economic assumption that people place a greater value on having resources available in the present than on delaying availability until the future.

Changes in ecological services resulting from a project depend in large part on the values assigned to different habitat and land cover types. The HEA model assigns values for intertidal, subtidal, and upland habitat and land cover types based on their relative importance for fish and wildlife productivity. Table 2 lists the habitat and land cover types with associated values that are commonly accepted by resource agencies. These are the values the Port will use to calculate ecological benefits and/or adverse impacts of bankline repair and maintenance actions under the Program. Nearly all treatments align well with the existing HEA habitat and land cover types. However, some types associated with Port facilities may not be addressed adequately in the commonly accepted version of the HEA. In those cases, the Port will consult with permitting agencies to negotiate appropriate values.

Table 2. Proposed HEA input values for habitats and substrates associated with bankline repair and enhancement activities.

General HEA Category	Functional Value	Years until Full Function

General HEA Category	Functional Value	Years until Full Function
Unvegetated uplands	0.0	NA
Urban greenbelt		
Riprap	0.1	1
Riparian	0.4	8
Fully functioning estuarine marsh	1.0	15
Fully functioning intertidal/mudflat	0.9	8
Baseline adjusted estuarine marsh	0.85	15
Baseline adjusted intertidal	0.75	4
Degraded intertidal	0.1	1
Fully functioning shallow subtidal	0.7	8
Baseline adjusted shallow subtidal	0.55	4
Degraded shallow subtidal	0.1	1
Fully functioning deep subtidal	0.3	1
Baseline adjusted deep subtidal	0.3	1
Degraded deep subtidal	0.1	1

For each project, Port staff will generate pre-project (baseline) and post-project polygons for use in the HEA model. Port staff will use existing geospatial data (e.g. bathymetric contours) and engineering plans to delineate existing and proposed habitat and land cover types in the project area. In some cases, additional data or information may need to be gathered in the field. Port staff will then calculate dSAYs for the project. A memorandum summarizing the results of the HEA will be submitted with permit materials to all relevant permitting agency staff.

Ledger

Calculating and recording HEA credits and debits for each project will allow the Port to track overall progress toward its restoration objectives. Credits (positive dSAY results) generated by bankline projects may be used to offset minor adverse impacts (negative dSAY results, or debits) from other bankline projects within the Program. This Program may be used to permit bankline enhancement that serves as compensatory mitigation for a separate Port project with unavoidable impacts. If this occurs, those credits will not be double-counted (i.e., not counted towards the credit/debit portion of the ledger). Furthermore, the project information form will clearly identify any project that will be used to mitigate for project impacts outside the Program.

Table 3 shows the ledger format used to track bankline repair and enhancement projects and associated HEA results. Table 3 includes examples of past bankline repair and enhancement projects.

Table 3. Example HEA ledger for tracking of Bankline Repair and Enhancement Program projects

Facility/ Project Name	Project Completion Date	Pre-treatment Condition	Post-treatment Condition	Multi-site Program HEA value (dSAYs)[1]	Non-Program Compensatory HEA value (dSAYs)[1]	Zone
SBM Step Wall Replacement	2013	Step Wall Bulkhead	Step Wall Bulkhead, Intertidal Bench	<marginal gain>	0	Marine
MIC Central Bulkhead	2011	Vertical Bulkhead	Vertical Bulkhead	<marginal loss>	0	Freshwater
FT West Wall Replacement	2002	Vertical Bulkhead	Vertical Bulkhead	<marginal loss>	0	Freshwater
T91 Cruise Repair	NA	Conventional Armored Slope	Sloped Bulkhead	Marginal loss, -.12	0	Marine
T5 Sheet Pile Wall Removal	2018	Vertical Bulkhead	Conventional Armored Slope and Top of Bank Riparian	<moderate gain>	0	Marine
T5 Public Shoreline Access Riprap and Bulkhead Repair	2010	Bulkhead and Conventional Armored Slope	Conventional Armored Slope	<marginal gain>	0	Marine
T86 Centennial Park Repair (3 projects)	2013-2017	Conventional Armored Slope	Conventional Armored Slope, On-slope Riparian, and Transitional Anchor System	<moderate gain>	<moderate gain>	Marine
T104 Intertidal Bench	1992	Conventional Armored Slope	Conventional Armored Slope, Intertidal Bench	<moderate gain>	0	Estuarine
T105 Public Access Repair	2016	Conventional Armored Slope	Top of Slope Riparian, On-slope Riparian, Transitional Anchor System, Natural Beach	<moderate gain>	0	Estuarine

Facility/ Project Name	Project Completion Date	Pre-treatment Condition	Post-treatment Condition	Multi-site Program HEA value (dSAYs)[1]	Non-Program Compensatory HEA value (dSAYs)[1]	Zone
8th Ave / S Park Public Access Site and South Riverside Drive (2 projects)	2015	Conventional Armored Slope	Transitional Anchor System, Emergent Marsh Bed, Top of Slope Riparian, On-slope Riparian	<moderate gain>	0	Estuarine
T108 Industrial/Public Access Site	2015	Conventional Armored Slope	On-slope Riparian, Transitional Anchor System, Emergent Marsh Bed	<moderate gain>	0	Estuarine

[1]For past projects, specific HEA values were not calculated. General HEA value included for illustrative purposes.

As shown in the table above, for each project Port staff will specify the location of the project according to the following zones:

- Estuarine – Duwamish Waterway (including EWW and WWW - River Miles 0.0 to 5.0)
- Marine – Elliott Bay and Puget Sound
- Freshwater – Lake Washington Ship Canal and Salmon Bay

Future research and development may lead to separate HEA models or model parameters tailored to the distinct conditions of a project site. Tracking HEA results separately for each zone will allow the Port to apply new information to projects at Port properties located in these other environments as such information becomes available.

Mapbook of Existing Bankline Types

As stated previously, the first page of the Mapbook presents a summary of bankline conditions in terms of linear feet and percentage of total Port bankline. Maintaining and updating this summary, and the geospatial data supporting it, will allow Port staff to track Port-wide changes in bankline conditions over time (Attachment F).

2.1.3 Program Compliance

Project Notification

The Port will transmit each project notification form to the Corps, WDFW, Ecology, and the tribes at least 60 days prior to anticipated construction. The Port will use a Project Information Form similar to that utilized for the Pile Systems Repair and Maintenance Programmatic Permit. Details will include the following:

- Project location, size, and description summary
- Project Manager and applicant contact information
- Summary of existing conditions
- Summary of decision process to select preferred treatments
- Project-specific drawings, including temporary erosion and sediment control plan and stormwater pollution prevention plan, if applicable
- Selected conservation measures- including monitoring, if applicable
- Construction date and duration
- Pre- and post-HEA results
- Applicable water quality monitoring procedures per water quality monitoring plan

Concurrence Process

All bankline repair and enhancement activities conducted as part of this Program within CERCLA or MTCA designated cleanup sites will be coordinated with the EPA and/or Ecology and will be designed to not preclude or foreclose future cleanup options. All projects will also be subject to individual Shoreline Master Program compliance review by the local jurisdiction.

Construction and Post-construction Reporting

The Port will send notification of construction start and completion dates. Any and all additional construction or post-construction-related monitoring and reporting will be completed as stipulated in project conservation measures or conditions. A monitoring report or memorandum will be prepared in each monitoring year of the program to provide a brief summary of conditions and any recommendations for further maintenance or repair necessary to meet performance standards.

Annual Reporting

The Port will provide the agencies an annual report, including a summary of the projects and a copy of the HEA ledger following each calendar year.

2.2 Action Area

The Action Area is defined as "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).

The Action Area includes the 29 Port-controlled sites in the Duwamish Waterway (including the EWW and WWW), Elliot Bay, North Seattle/Puget Sound, and the Lake Washington Ship Canal, shown in Attachment F.

The Action Area also includes the area of potential effects beyond the Port-controlled sites. Airborne and underwater noise associated with pile replacement and removal tends to have the farthest potential effect on listed fish and wildlife of the actions proposed under this programmatic permit. The extent of potential underwater noise based on the distance for sound from impact pile installation of 24" steel sheetpile to attenuate to ambient noise (Peak dB of 205, SEL of 180dB, RMS of 190 dB and background noise levels of 130 dB) extends up to 25,119 m (15.6 miles) from project activities, as shown in Figure 1. Physical barriers to noise transmission limit the total area in which underwater noise is transmitted. The extent of potential airborne noise based on impact pile driving of sheetpile (103 dB based on 24-inch sheet pile with background noise of 55 dB) is approximately 2.4 miles, and is also shown in Figure 1.

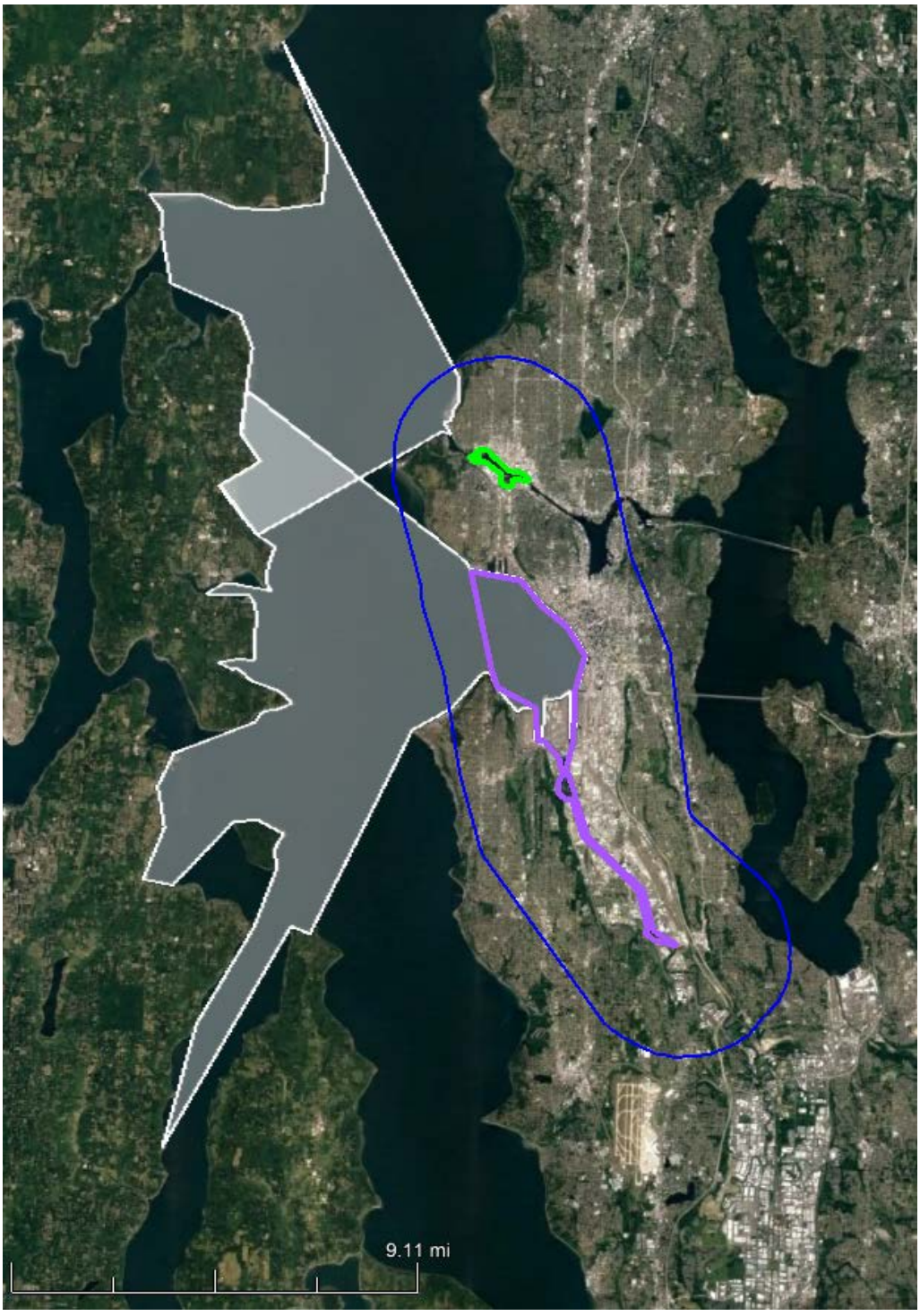

Figure 1. Action area based on distance for sound to attenuate to ambient levels. Underwater marine zone action area outlined/shaded in white, estuarine zone action area outlined in purple, and freshwater zone action area outlined in green. Maximum extent of airborne noise outlined in blue.

Section 3. Environmental Setting

3.1 Environmental Baseline

This section describes the general habitat conditions in the Action Area with respect to the listed species with potential to occur and the primary constituent elements (PCEs) or physical or biological features of designated critical habitat for listed species. The baseline discussion summarizes the actions that have occurred and continue to occur in the Action Area and describes how these actions have influenced environmental conditions and the status of the species in the Action Area.

The general environmental baseline in the Lower/Green Duwamish, Elliot Bay, North Seattle/Puget Sound, and the Lake Washington Ship Canal are described in the Seattle Biological Evaluation (City of Seattle 2015). Refer to the Mapbook of existing bankline conditions (Attachment F) and Table 4, below, for information on the type of bankline protection at specific Port-controlled properties.

Table 4. Length of Port-controlled bankline

Property name (organized from north to south)	Action Area Zone	Length of existing bankline (lineal feet)									
		Vertical bulkhead	Bulkhead and conventional armored slope	Sloped bulkhead/ boat ramp	Step wall bulkhead	Conventional armored slope	Rubble-strewn slope	Alternative stabilization	Marsh	Natural beach	Total length
Shilshole Bay Marina	Marine		4,242		447						**4,689**
Maritime Industrial Center	Freshwater	787						36			**824**
Salmon Bay Marina	Freshwater	667									**667**
Fishermen's Terminal	Freshwater	2,869		291							**3,159**
Terminal 91	Marine	278	9,518			4,649				75	**14,520**
Terminal 86 and Centennial Park	Marine		58			3,810					**3,868,**
Pier 69	Marine	156	405								**560**
Pier 66	Marine		2,077			212					**2,290**
Terminal 46	Marine		4,801			212					**5,013**
Terminal 30	Estuarine	650	3,319			200					**4,168**
Terminal 18 North	Marine		489			1,282					**1,770**
Terminal 18 Center and South	Estuarine		6,125								**6,125**
Terminal 25	Estuarine		1,698			1,974					**3,672**
Terminal 10	Estuarine		1,259	205				146		110	**1,720**
Terminal 18 Public Access	Estuarine					382					**382**

Property name (organized from north to south)	Action Area Zone	Length of existing bankline (lineal feet)									
		Vertical bulkhead	Bulkhead and conventional armored slope	Sloped bulkhead/ boat ramp	Step wall bulkhead	Conventional armored slope	Rubble-strewn slope	Alternative stabilization	Marsh	Natural beach	Total length
Terminal 5 North	Marine	159	819			45	139				**1,162**
Terminal 5 South	Estuarine		3,251		225	509					**3,986**
Pier 2 and Jack Block Park	Marine		160			1,389				642	**2,191**
Terminal 5 SE	Estuarine		71		158	90					**319**
Terminal 102	Estuarine					1,944					**1,944**
Terminal 104	Estuarine		185			725					**910**
Terminal 103	Estuarine		313			516					**830**
Terminal 105	Estuarine					342	169	304	1,044		**1,858**
Terminal 106	Estuarine					1,360					**1,360**
Terminal 108	Estuarine					854		275	283		**1,411**
Terminal 107 and Kellogg Island	Estuarine					761	1,076		1,347	3,008	**6,193**
Terminal 115	Estuarine		1,243		201	1,746					**3,189**
Terminal 117	Estuarine	377				825					**1,202**
Turning Basin #3	Estuarine								1,577		**1,577**
Total		**5,942**	**40,032**	**496**	**1,031**	**23,828**	**1,384**	**761**	**4,251**	**3,835**	**81,561**

3.1.1 Duwamish Waterway

The Duwamish Waterway within the Action Area is tidally influenced, with a saltwater wedge extending up to approximately River Mile (RM) 7, at the southern edge of the Action Area.

The Duwamish Waterway is the center of shipping and industrial activities for the City of Seattle. Properties along the Duwamish Waterway predominantly support water-dependent and water-related uses associated with marine transport. Nearly all of the historic tidal marshes, which once predominated in the Duwamish Waterway were filled in the late 19th and early 20th centuries. Historic sources of flow have been greatly diminished compared to their natural rates as a result of the diversion of the White River into the Puyallup River in 1906 and the diversion of the Cedar River into Lake Washington in 1916. The diversion of these rivers reduced the Duwamish/Green drainage basin by 75% and its average flow by up to 81%. At about the same time, the lower river was dredged to create the Duwamish Waterway, replacing 9 meandering miles (14.4 km) of river with a straight, deep, 5.3-mile-long (8.5 km) navigation channel (City of Seattle 2003).

Water and sediment quality in the Duwamish Waterway has been adversely affected by the history of surrounding high-intensity land use, as well as municipal stormwater and wastewater outflows. The Duwamish Waterway is on the State's 303(d) list of impaired waterbodies for bacteria, dissolved oxygen, and water temperature. Thirty three sediment contaminants are also identified on the 303(d) list for the Duwamish Waterway. The Duwamish Waterway was designated a Superfund Site by the United States Environmental Protection Agency (EPA) in 2001. A Cleanup Plan issued by the EPA in 2014 identified technologies and extent of planned cleanup activities. The river has also been listed for cleanup by Washington State under the Model Toxics Control Act (MTCA).

3.1.2 Puget Sound

Puget Sound shorelines within the Action Area are highly urbanized, with land uses including maritime industrial, commercial, and residential. Port properties on Puget Sound include materials terminals, cruise-ship terminals, Port offices, public parks, and marinas. The Shilshole Marina is fronted by a riprap breakwater, which protects moorage areas from predominant north winds in summer and south winds in winter. Potential repairs to the Shilshole Marina breakwater are included in this programmatic permit.

Given the extensive modification of Elliott Bay and the Shilshole Marina, natural processes of sediment accretion and erosion are highly altered in the vicinity. Nevertheless, Elliott Bay supports a few areas of remaining eelgrass and kelp bed habitats.

High levels of bacteria have been documented in nearshore areas of Elliott Bay and Puget Sound, and portions of the marine Action Area are identified as impaired by the Washington Department of Ecology; these areas occur in and around the Shilshole Marina, along Centennial Park, and north of Terminal 46.

3.1.3 Lake Washington Ship Canal

The hydrology and habitat of the Lake Washington Ship Canal are substantially altered. The lake was lowered by approximately 8 feet through excavation of the Montlake Cut and construction of the Hiram Chittenden Locks. Furthermore, the now-managed hydroperiod above the Locks is reversed, meaning that the lake level is approximately two feet higher in the summer compared to in the winter. The Ship Canal supports significant marine commercial and industrial activity, with substantial areas of overwater coverage and shoreline armoring.

Water quality within the Lake Washington Ship Canal is on Ecology's 303(d) list of impaired waterbodies for lead, pH, aldrin, and bacteria.

3.2 Presence/Status of Listed Species and/or Designated Critical Habitat in Action Area

Federally-listed species whose geographic range extends into at least a portion of the Action Area are identified in Table 5 and described below.

Table 5. Federally listed species whose range extends into the Action Area

Species	Federal Status	Action Areas	Critical Habitat Within Action Area
Puget Sound Chinook salmon *Oncorhynchus tshawytscha*	Threatened	All areas	All areas waterward of OHW or MHHW
Puget Sound steelhead *Oncorhynchus mykiss*	Threatened	All areas	All areas waterward of OHW along the Lower Duwamish River
Coastal-Puget Sound bull trout *Salvelinus confluentus*	Threatened	All areas	All areas waterward of OHW or MHHW
Killer whale: Southern Resident *Orcinus orca*	Endangered	Marine only	All waters in Puget Sound deeper than 20 ft (6.1 m)
Humpback whale *Megaptera novaeangliae*	Endangered (Central America), Threatened (Mexico)	Marine only	No critical habitat has been designated for the humpback whale
Marbled murrelet *Brachyramphus marmoratus*	Threatened	Marine only	No critical habitat designated within the action areas. Marine environments were not designated.

Species	Federal Status	Action Areas	Critical Habitat Within Action Area
Eulachon *Thaleichthys pacificus*	Threatened	Marine only	No critical habitat designated within the action areas.
Bocaccio *Sebastes paucispinis*	Endangered	Marine/Estuarine only	Nearshore and deepwater habitat
Yelloweye rockfish *Sebastes ruberrimus*	Threatened	Marine only	Deepwater habitat (>30 m)

3.2.1 Puget Sound Chinook Salmon

Chinook salmon (Oncorhynchus tshawytscha) were designated threatened on March 24, 1999 (64 FR 14307). The threatened status was reaffirmed on June 28, 2005 (70 FR 37160).

The following discussions describe the use of different zones in the Action Area by Chinook salmon. Table 4 summarizes the timing in which juvenile and adult Chinook salmon may be present in the different zones of the Action Area.

Duwamish Waterway

Adult Chinook salmon enter the Duwamish River from approximately mid-June through October en route to upstream spawning habitat in the Green River. After entering the river, many early migrating Chinook salmon hold in the lower river (upstream of the Action Area) until approximately mid-September, depending on temperature and flow (Ruggerone et al. 2004).

Juvenile Chinook salmon typically begin emerging in January. Most Chinook salmon fry begin moving downstream soon after emergence, but others remain in freshwater for one year before beginning their seaward migration.

Subyearling Chinook salmon may be particularly dependent on estuarine rearing, particularly in off-channel habitats (Healey 1982, Healey 1991, and Simenstad et al. 1982). Juvenile Chinook salmon may occur in the Action Area during the spring outmigration period, which begins in late January and tapers off in early July (Ruggerone et al. 2006). Nearshore sampling in the Duwamish Estuary found that densities of unmarked subyearling Chinook salmon peaked in mid-March, and densities of yearling Chinook smolts peaked in early June (Cordell et al. 2006). Juvenile Chinook salmon typically spend several weeks rearing in the estuary. In 2002, residence time of natural Chinook salmon in the Duwamish estuary declined steadily from approximately 28 ± 7 days in late May to 20 ± 7 days in early June to 15 ± 3 days in late June (Ruggerone and Volk 2004).

The straightening, filling, and armoring of the Duwamish Waterway over time has resulted in limited areas of habitat refugia. Additionally, the presence of overwater structures and pilings that either presently support or once supported maritime industrial uses, results in transitions

in shading and in-water habitat features that support predatory fish species over small-bodied juvenile salmonids. Incremental gains in habitat functions have been realized, due in large part to Port initiatives to restore native marsh habitat, plant riparian vegetation, and remove derelict piles and overwater structures.

Ruggerone et al. (2006) found that salmon densities (all species) are higher in the area where freshwater and saltwater initially mix (River Mile [RM] 4.7-RM 6.5), compared to adjacent reaches in the lower estuary. This result may be associated with the relative availability of potential rearing habitat. Juvenile salmon densities in the Duwamish Waterway are greater in off-channel habitats compared to mainstem habitats (Ruggerone et al. 2006).

Chinook salmon originating from other river systems in the Puget Sound Basin may enter the lower estuary at any time of year, but analyses of coded-wire-tagged Chinook salmon indicates that non-natal Chinook salmon do not travel upstream of Kellogg Island (Nelson et al. 2004).

In summary, Chinook salmon may be present in the Duwamish Waterway during all months of the year. Juvenile Chinook salmon are most likely to occur in nearshore areas of the Action Area in February through June. Adult Chinook salmon are most likely to occur in the Action Area from approximately mid-June through October, although they do not tend to be associated with nearshore areas.

Lake Washington Ship Canal

Adult Chinook salmon begin to arrive in Salmon Bay, downstream of the Hiram Chittenden Locks in mid-June, where they hold prior to their freshwater migration. The peak time of entry through the Locks and into the Lake Washington basin occurs in mid-to late August and is generally complete by early November. Chinook salmon stock spawn upstream during a period ranging from mid-September through November (Kerwin 2001).

Juvenile Chinook salmon emerge in January through March. Most Chinook salmon migrate to sea as sub-yearlings. Early-migrant fry enter Lake Washington from Jan through March and rear in the south end of Lake Washington for several months. Other fry rear in the river and then migrate to the lake in May or June as pre-smolts. Some juveniles rear in freshwater for a year prior to migrating to sea.

Chinook salmon fry rear in shallow water areas. Juvenile Chinook salmon disperse to deeper water (1 to 6 m) as they grow larger (Fresh 2000, Piaskowski and Tabor 2001, Tabor et al. 2006). As juvenile Chinook salmon migrate into the Ship Canal, they are no longer shoreline oriented and are broadly distributed throughout off-shore, deep water areas (Celedonia et al. 2009). Juvenile Chinook salmon spend between 2 to 4 weeks migrating through the Ship Canal (DeVries 2005) before migrating through the Locks from May to September.

Similar to the Duwamish Waterway, extensive overwater cover and simplified, armored shorelines has impaired the quality of habitat for rearing juvenile salmonids, and instead favors potential predators. Studies of habitat use in Lake Washington found that more juvenile Chinook salmon used unretained shorelines compared to armored shorelines (Paron and Nelson 2001, Piaskowski and Tabor 2001, Tabor and Piaskowski 2002, Tabor et al. 2004, 2006).

To summarize, juvenile Chinook salmon are most likely to occur in the Lake Washington Ship Canal from May to September, and adult Chinook salmon may migrate through the Action Area from August through November.

Puget Sound

Adult Chinook salmon returning to freshwater drainages could be present in Puget Sound Action Area from mid-June to mid-October.

Studies on Chinook salmon use of Puget Sound have found that juveniles begin reaching nearshore areas in late January and early February (Williams et al. 2001), with peak migration into Puget Sound in June and July (Toft et al. 2004, Nelson et al. 2004). Juvenile Chinook salmon are found along the nearshore in low densities through October.

In general, densities of juvenile Chinook salmon in Puget Sound nearshore habitats are lower compared to densities in the Duwamish estuary (RM 0 to RM 7) (Nelson et al. 2004). Diet of juvenile Chinook salmon in Puget Sound varies depending on body size. Chinook salmon under 6 inches (150 mm) consume a mixture of polychaete worms, epibenthic invertebrates, and insects, while Chinook salmon larger than 6 inches (150 mm) consume mostly juvenile fish.

To summarize, Chinook salmon may be present in the Puget Sound Action Area throughout the year, with juveniles most likely to be present along the nearshore from February through July. Adults may be present from July through October, but they do not tend to be associated with nearshore habitats (Table 6).

Table 6. Depiction of timing of Chinook presence in each zone of the Action Area. Light gray indicates low probability and darker gray indicates high probability of presence.

Action Area Zone	Life Stage	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Duwamish	Juv												
	Adult												
Lake WA Ship Canal	Juv												
	Adult												

Action Area Zone	Life Stage	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Puget Sound	Juv												
	Adult												

Chinook Salmon Critical Habitat

NMFS designated critical habitat for Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat includes all waters waterward of extreme high water in marine and estuarine portions of the Action Area. In the Lake Washington Ship Canal, critical habitat extends landward to the ordinary high water mark (OHWM).

3.2.2 Puget Sound Steelhead

Puget Sound steelhead were listed as threatened under the ESA on May 11, 2007 (72 FR 26722).

Duwamish Waterway

Summer and winter steelhead trout occur within the Green/Duwamish River basin (WDFW electronic reference). Despite the separate runs, there is considerable overlap in the run timing and spawning for summer and winter steelhead (Busby et al. 1996). In the Green River, adult steelhead typically enter freshwater from December to April and spawn shortly thereafter (Busby et al. 1996). Both stocks are thought to spawn in the Green River below the Tacoma Water Diversion Dam and in larger tributaries like Soos and Newaukum Creeks. Steelhead exhibit a highly variable anadromous life history. Juveniles generally emigrate as smolts between April and June, after two years of stream residence. However, the duration of freshwater rearing can range from one to seven years before juveniles grow large enough (>170 mm) to undergo smoltification.

Because steelhead are larger bodied prior to migration to saltwater, they are typically less dependent on nearshore areas for foraging and protection from predators during outmigration compared to the much smaller juvenile Chinook salmon. Sub-adult and adult steelhead may use the deeper waters near the Action Area for migration and foraging, but are not expected to be present in significant numbers at any time. Occasional opportunistic foraging in the Action Area is possible while in transit down the Duwamish Waterway.

Lake Washington Ship Canal

Adult steelhead begin migrating upstream through the Locks beginning in October (NMFS 2005) and continue through April. The steelhead spawning period in the Lake Washington basin extends from March to September. Fry emerge from Lake Washington tributary streams from late May to early August (peaking in July) (Table 7). The duration of freshwater rearing

can range from one to seven years before juveniles grow large enough (>170 mm) to undergo smoltification. Juveniles generally emigrate as smolts through the Locks in mid-June to early July (Kerwin 2001).

Puget Sound

Steelhead move rapidly through estuaries and nearshore waters to forage on larger prey in offshore marine areas. Although steelhead presence in the nearshore is rare, nearshore areas may provide important functions to steelhead prey species, such as forage fish.

Table 7. Depiction of timing of steelhead presence in each zone of the Action Area. Light gray indicates low probability and darker gray indicates high probability of presence.

Action Area Zone	Life Stage	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Duwamish	Juv												
	Adult												
Lake WA Ship Canal	Juv												
	Adult												
Puget Sound	Adult												

Steelhead Critical Habitat

Critical habitat was designated for Puget Sound steelhead on February 24, 2016 (81 FR 9251). The critical habitat designation excluded nearshore areas of Puget Sound because steelhead move rapidly out of freshwater and into offshore marine areas. The entire Lake Washington watershed was also excluded from critical habitat for economic reasons. Therefore, within the Action Area, only areas within the Duwamish Waterway to the northernmost point of Harbor Island are included in critical habitat for Puget Sound steelhead. Critical habitat includes those areas waterward of the OHWM in the Duwamish Waterway.

3.2.3 Coastal Puget Sound Bull Trout

Coastal Puget Sound bull trout were designated as threatened on November 1, 1999.

Duwamish Waterway

Adult bull trout have been identified in the Green/Duwamish River basin and may use this area for foraging, migration and overwintering; however, spawning has not been documented in the Green River (WDFW electronic reference). Historically, bull trout were reported to use the Duwamish River and lower Green River in "vast" numbers (Suckley and Cooper 1860 in

USFWS 2004). In contrast, bull trout are rarely observed in the Green/Duwamish system today (USFWS 2004).

Bull trout occurrence in the Duwamish River has been documented several times over the past few decades. Anecdotal presence of four adult char was reported in April 1978 at RM 7 of the Duwamish River (USFWS 2004). Subadult bull trout were caught in late summer at the Turning Basin (RM 5.3) in 2000 and 2002 (USFWS 2004). In May of 2003, a large adult bull trout (582 millimeters; 23 inches) was captured in the Duwamish Waterway at Kellogg Island (USFWS 2004). Based on the available information, it is expected that bull trout are uncommon in the Action Area.

Lake Washington Ship Canal

Bull trout are not commonly observed within the Lake Washington basin outside of a non-migratory population in the far-upstream Lake Chester Morse water supply reservoir (WDFW SalmonScape). Bull trout are observed at the Ballard Locks on an annual basis with numbers observed or caught varying from three to nine fish per year (Goetz, pers. comm., 14 May 2004). In Lake Washington, bull trout have been caught and observed during winter and spring, typically in the south Lake Washington/Cedar River area. There is no known spawning subpopulation resident in Lake Washington.

Additionally, surface water temperatures in Lake Washington and the Ship Canal are too warm for bull trout during late spring through early fall and probably limit residence time of bull trout that may enter the system through the Locks.

Puget Sound

Anadromous bull trout migrate from freshwater between ages 1 and 3. Adult and sub-adult bull trout may be found in nearshore marine waters year-round; however, the period of greatest use is March through July (Goetz and Jeanes 2004), corresponding with presence of forage fish and salmon smolt prey. Bull trout caught in Shilshole Bay and at the Locks between May and July were found preying upon juvenile salmon (40% of diet) and marine forage fish (60% of diet) (Footen 2000, 2003). A total of 34 bull trout have been captured in Shilshole Bay since 1949. In Elliott Bay, 1 bull trout was observed feeding along the new habitat bench created at the Olympic Sculpture Park in June (Toft et al. 2010).

Table 8. Depiction of timing of bull trout presence in each zone of the Action Area. Light gray indicates low probability and darker gray indicates high probability of presence.

Action Area Zone	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Duwamish												

Action Area Zone	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Lake WA Ship Canal												
Puget Sound												

Bull Trout Critical Habitat

Bull trout critical habitat was designated on September 26, 2005 (70 FR 56212) and revised on October 18, 2010 (75 FR 63898). Designated critical habitat includes the bankfull width of rivers, and estuarine and marine nearshore areas from the MHHW to -30 ft MLLW.

3.2.4 Southern Resident (SR) Killer Whale

Southern resident killer whales were listed as endangered on November 15, 2005.

The following description is a collection of excerpts from the final rule designating the southern resident killer whale as an endangered species (71 FR 69054).

> *"[Killer whales] reportedly occur year-round in the waters of southeastern Alaska (Scheffer, 1967) and the intercoastal waterways of British Columbia and Washington State (Balcomb and Goebel, 1976; Bigg et al., 1987; Osborne et al., 1988). There are occasional reports of killer whales along the coasts of Washington, Oregon, and California… Resident whales occur in large, stable pods with membership ranging from 10 to approximately 60 whales. Their presence has been noted in the waters from California to Alaska. The primary prey of resident whales is fish… The Southern Resident killer whale assemblage contains three pods-- J pod, K pod, and L pod--and is considered a stock under the MMPA [Marine Mammal Protection Act]. Their range during the spring, summer, and fall includes the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. Their occurrence in the coastal waters off Oregon, Washington, Vancouver Island, and more recently off the coast of central California in the south and off the Queen Charlotte Islands to the north has been documented. Little is known about the winter movements and range of the Southern Resident stock.*
>
> *Concern remains about whether reduced quantity or quality of prey are affecting the Southern Resident population. In addition, levels of organochlorine contaminants are not declining appreciably and those of many ''newly emerging'' contaminants (e.g., brominated flame retardants) are increasing, so Southern Residents are likely at risk for serious chronic effects similar to those demonstrated for other marine mammal species (e.g., immune and reproductive system dysfunction). Other important risk factors that may continue to impact Southern Residents are sound and disturbance from vessel traffic as well as oil spills."*

During the period of residence in Puget Sound from late spring to summer, SR killer whale activity is concentrated around the San Juan Islands. SR killer whales tend to move south into Puget Sound in early autumn, likely following chum and Chinook salmon runs. The presence of Southern Residents in Puget Sound is intermittent, with the smallest number of sightings in May-July. Despite these general seasonal patterns, SR killer whales have the potential to occur in the Action Area at any time of the year.

Southern Resident Killer Whale Critical Habitat

Critical habitat was designated on November 29, 2006 (71 FR 69054). Critical habitat includes all waters relative to a contiguous shoreline delimited by the line at a depth of 20 feet (6.1 m) relative to extreme high water. Waters deeper than 20 feet in Puget Sound are included in the Area 2- Puget Sound Critical Habitat.

3.2.5 Humpback Whale

Humpback whales were listed as endangered on June 2nd, 1970, the designation was revised on September 8th, 2016 (81 FR 62259). Critical habitat has not been designated. Under the revised ESA designation, the Mexico DPS of humpback whale was listed as threatened, and four other DPSs (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea DPSs) were listed as endangered. Both the Central America and Mexico DPSs migrate to the coast of California to southern British Columbia in summer.

Humpback whales typically inhabit coastal areas and they may occur in Puget Sound in any month. Calambokidis and Steiger (1990) described the rarity of humpback whales in Puget Sound; however, the occurrence of humpback whales in the Salish Sea has increased, with hundreds of sightings in recent years (Cascadia Research electronic reference http://www.cascadiaresearch.org/projects/return-humpback-whales-salish-sea). Humpback whales may occur in the Action Area of Puget Sound; however, given the confined nature of the Duwamish Waterway and the level of human activity, we assume that humpback whales will not occur within the Duwamish Waterway.

3.2.6 Marbled Murrelet

Marbled murrelets were designated as threatened in 1992 (57 FR 45328).

Marbled murrelets may forage throughout the year in nearshore waters ranging from 3 to 300 feet in depth, and typically within 1.2 miles from shore (Strachan et al. 1995). Murrelets prey on forage fish and marine invertebrates. Marbled murrelets generally select nests within 37 miles of marine waters (Miller and Ralph 1995), and they could occur within the Action Area. However, given the highly urbanized environment within the Action Area, with significant commercial vessel traffic and limited availability of forage fish, marbled murrelets are unlikely to be present.

Critical habitat for the murrelet was designated in 1996 (61 FR 26256). Critical habitat does not include marine foraging areas; therefore, critical habitat does not occur within the Action Area.

3.2.7 Bocaccio

Puget Sound/Georgia Basin DPS of bocaccio was listed as endangered on April 28th, 2010 (75 FR 22276).

Larval rockfish are transported by marine currents and tides. Following their larval stage, juvenile bocaccio may settle in shallow, intertidal marine habitats, including rocky, cobble, and sand substrates with or without eelgrass or kelp before moving to deeper waters (Blackmon et al. 2006, Peterson et al. 2010). Suitable habitat for bocaccio is limited on Port-controlled properties, where the majority of the bankline is altered with hard shoreline stabilization. Bocaccio would only occur within the marine and lower estuarine portions of the Action Area (see critical habitat description below). Adult bocaccio are associated with rocky habitats at depths over 30 m, and they may be present within marine waters in the action area (79 FR 68041).

Bocaccio Critical Habitat

Critical habitat for the Puget Sound/Georgia Basin DPS of bocaccio was designated on November 13, 2014 (79 FR 68041).

Critical habitat includes marine waters in the Action Area from extreme high water to -30 meters MLLW, to the north end of Harbor Island.

3.2.8 Yelloweye Rockfish

Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as threatened on July 27th, 2010 (75 FR 22276).

Unlike bocaccio, juvenile yelloweye rockfish do not typically settle in intertidal habitats, and few have been documented in shallow waters outside or inside the Puget Sound/Georgia Basin (79 FR 68042). Adult yelloweye rockfish are associated with rocky habitats at depths over 30 m; therefore, adults would not be present in or near the action area.

Yelloweye Rockfish Critical Habitat

Critical habitat for the Puget Sound/Georgia Basin DPS of yelloweye rockfish was designated on November 13, 2014 (79 FR 68041).

Critical habitat is limited to waters 30 meters below MLLW and deeper.

3.2.9 Eulachon

The southern DPS of Pacific eulachon (Thaleichthys pacificus) were listed as threatened under the ESA on May 17, 2010 (75 FR 13012).

Eulachon are anadromous forage fish that spawn in the lower reaches of large rivers. Following emergence, larval eulachon are carried out of their natal rivers, into estuarine and ocean waters. 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). The only documented eulachon spawning near Puget Sound is in the Fraser River in southern British Columbia, and understanding and documentation of the distribution and life histories of eulachon in Puget Sound is extremely limited (Penttila 2007). Eulachon are not expected to occur in the Action Area; therefore, the project will have no effect on eulachon, and the species will not be addressed further in this document.

Critical habitat for the southern DPS of Pacific eulachon was designated on October 20, 2011 (76 FR 65324). The nearest designated critical habitat is at the Elwha River, over 70 miles from the Action Area. Therefore, critical habitat is not present within the Action Area.

Section 4. Interrelated and Interdependent Effects

Interrelated and interdependent actions are those that would only occur or are dependent on the proposed action. Interrelated actions are those "that are part of a larger action and depend on the larger action for their justification," while interdependent actions are defined as those "with no independent utility apart from the proposed action."

There are no specific interrelated and interdependent actions anticipated. Repair and maintenance of banklines is essential to continued use of the Port's water-dependent activities. No long-term changes in ongoing activities are anticipated as a result of the Port's repair or maintenance activities. Conversely, the Port plans to conduct repair and maintenance of its bankline facilities regardless of any proposed changes in the use of Port-controlled facilities.

Section 5. Effects to Species

5.1 Methodology

This effects analysis considers the existing condition (environmental baseline) of the Action Area and how the proposed action would change (or not change) the existing condition with regard to effects on threatened and endangered species and designated critical habitat. The approach considers both short-term effects (i.e., during construction) and long-term effects.

The effects analysis will consider the potential effects to the species and habitat from the proposed action, the nature and extent of the species' response(s) within the context of the environmental baseline conditions, and will describe the rationale for the resulting effects determinations.

5.2 Salmonids

The proposed project could potentially affect bull trout, Chinook, and steelhead trout in generally similar manners. Unless otherwise noted, there is no distinction between those species within the following discussion.

5.2.1 Direct Effects

This section describes direct effects of the proposed action on listed species and critical habitats. Direct effects are those that occur at, or very close to, the time of the action itself.

Water quality

Several Port-controlled properties are within areas with known soil and/or groundwater contaminants. All bankline repair and enhancement activities conducted as part of this Program within CERCLA or MTCA designated cleanup sites will be coordinated with the EPA and/or Ecology and will be designed to not preclude or foreclose future cleanup options.

Turbidity

Project activities involving grading, excavation, or fill in or adjacent to waterbodies have the potential to contribute to temporary increased turbidity in adjoining waters.

High levels of total suspended solids (TSS), which are often, but not always, correlated with high turbidity, are generally considered undesirable for salmonids, as exposure to potentially contaminated or abrasive sediments suspended in the water column may result in lethal and sub-lethal effects (Newcombe and MacDonald 1991, Bash et al. 2001). However, turbidity can have beneficial effects on salmonid feeding and provide protection from piscivorous predators (Gregory 1994, Gregory and Levings 1998, Mazur and Beauchamp 2003, Mazur and Beauchamp 2006). Juvenile Chinook salmon of the body size that could be present at the site were found to

have their peak foraging rates when turbidities were between 70-150 NTUs (Gregory 1994), conditions generally considered to be moderate to highly turbid water.

To minimize adverse effects of turbidity, conservation measures will be implemented, such as temporary erosion and sediment control measures, work in the dry to the extent feasible, work area isolation, and the use of sediment curtains. In addition, project work will follow established in-water work windows so that temporary project-related turbidity is most like to occur when listed salmonids are least likely to occur within the action area. Finally, a programmatic Water Quality Monitoring and Protection Plan has been prepared, which establishes procedures and thresholds for water quality monitoring and protection. If those thresholds are exceeded, work will stop and the activity will be modified to ensure that water quality standards are met.

pH

Uncured concrete can harm aquatic invertebrates and fish by increasing pH of adjacent waters. The repair and maintenance activities allowed under this programmatic permit will avoid cured-in-place concrete to the extent feasible. Where cured-in-place concrete is needed, the project will avoid potential impacts from exposure to uncured concrete by allowing concrete to set prior to removal of forms and exposure to seawater. In addition, by following established periods for in-water work, any temporary exposure to elevated pH would be expected in a period when listed salmonids are least likely to occur within the action area.

Shallow water habitat

Juvenile Chinook salmon rear and migrate in shallow freshwater, estuarine, and marine waters. In Lake Washington, studies have found that in early spring, juvenile Chinook salmon rear along shorelines less than 0.5 m (1.6 feet) deep, moving in to deeper waters of 2 m (6 feet or more) as they grow (Tabor et al. 2006). In estuarine and marine waters, juvenile Chinook salmon tend to occur in depths less than 12 feet, where they forage on benthic and terrestrial invertebrates and forage fish (Brennan et al. 2004). Structural stabilization measures, particularly vertical measures, reduce or eliminate potential shallow-water rearing areas preferred by juvenile Chinook salmon.

Bankline repair and maintenance under this programmatic permit will require the use of alternative stabilization and ecological enhancement to the extent feasible to increase shallow water habitat opportunity and enhance habitat functions. In many cases, the project will maintain a structurally stabilized shoreline, as necessitated by water-dependent uses, yet over time, shallow water habitat functions are expected to improve through an increase in riparian vegetation, increased shoreline complexity, and expansion of natural shallow water habitats, relative to baseline conditions. In the short-term, individual project activities have the potential to affect vegetated shallow water habitat through temporary shading effects, turbidity, and disturbance. These temporary disturbances are not expected to result in permanent adverse

impacts to shallow water habitats because this programmatic permit does not allow expansion of shoreline stabilization.

Overall, the project will improve conditions relative to the baseline; however, because the program may also include in-kind replacement of vertical bulkheads, there is the potential to adversely affect juvenile Chinook salmon through program actions.

Juvenile steelhead and bull trout are not closely associated with shallow water habitat; therefore, project effects on steelhead and bull trout through effects to shallow water habitat are insignificant.

Noise

The replacement of sheetpile bulkheads and the removal of derelict piles at or immediately waterward of the bankline will result in underwater noise that could affect salmonids. The potential extent of disturbance depends on the location and whether impact pile driving (installation only) is required. As indicated in the Port's underwater noise manual (Ewald and Sloan 2011, included as Appendix C), underwater noise generated from vibratory removal of derelict piles and installation of sheet piles would not exceed 171 dB_{RMS}, which is below the injury threshold for fish, including salmonids, but above the behavioral disturbance threshold. In the instances where sheetpile replacement is proposed, the potential for injury from cumulative sound exposure exists within 251 m of the project activity (this assumes 24" steel sheet pile) (Ewald and Sloan 2011). This injury potential would be limited to relatively brief periods of impact pile driving. Behavioral disturbance could extend up to 1,166 m from project activities. Pile removal and replacement will occur during approved in-water work periods when listed salmonids are least likely to be present. Sheet piling will be installed with a vibratory device whenever possible. An impact hammer may be used to proof piles, if needed. Given the limited use of impact pile driving, and because the timing of any sheetpile replacement activity when salmonids would be unlikely to be present, the effect of underwater noise on threatened salmonids is expected to be insignificant.

Fish removal/exclusion

Where work area isolation is needed, and where such isolation cannot be accomplished in the dry (during low tide), fish exclusion and removal efforts will be necessary. This may include herding fish out of the work area using large seine nets, or capturing fish using a seine and relocating them outside of the work area if herding is not possible. These activities have the potential to result in harassment or injury of herded or captured salmonids. The best way to avoid take of salmonids when fish removal or exclusion is required is to conduct such activities when listed salmonids are not likely to occur within the action area. Project activities under this programmatic permit will occur during work windows established by the Services and WDFW, with input from affected tribes. Best management practices will be employed to minimize injury to any fish that are encountered (whether listed or not). As such, it is unlikely that any listed

species would be encountered during fish removal and exclusion activities, and if they were encountered, best practices would minimize harassment or injury resulting from the activity.

Direct mortality

To the extent that listed salmonids are present within the action area during project activities, there is the potential to result in direct mortality. This potential will be avoided and minimized by scheduling work according to tidal cycles such that in-water work is avoided or minimized and by following established work windows such that the potential for project actions to result in direct mortality is discountable.

5.2.2 Indirect Effects

Potential effects to salmonid prey may include effects to prey through habitat modifications. Intertidal marshes, mudflats, and riparian buffers may support detrital food webs, insects, and benthic invertebrates, which support the estuarine diets of juvenile salmonids. Bankline enhancement proposed as components of this programmatic permit, such as riparian communities, intertidal marshes, and mudflat benches will support invertebrate production and salmonid prey habitat. Other habitats, such as eelgrass beds and intertidal marine beaches may support forage fish spawning habitat. Forage fish are important prey items for adult salmonids in the marine environment. Forage fish spawning habitat has not been documented on Port properties, yet recent and proposed Port restoration projects may support habitats that forage fish spawning potential. In summary, the proposed alternative stabilization measures associated with this programmatic permit are expected to increase the availability of salmonid prey within the Action Area.

5.3 Southern Resident Killer Whale

5.3.1 Direct Effects

Noise

The replacement of sheetpile bulkheads and the removal of derelict piles at or immediately waterward of the bankline will result in underwater noise that could affect SR killer whales. Noise from impact driving of sheetpile falls below the injury threshold for cetaceans (180 dB_{RMS}) within 12 m of the noise-generating activity. Noise from vibratory pile installation and extraction does not exceed the injury threshold for marine mammals. Underwater noise from vibratory and impact driving can exceed the behavioral disturbance thresholds (ambient and 160 dB RMS, respectively) a maximum distance of 2,154 m based on the loudest vibratory installation of 24" steel sheet pile. The distance of sound disturbance from removal of derelict wood piles or steel piles 12" or less in diameter would be lower than from sheet pile (Ewald and Sloan 2011, Appendix C).

The potential extent of disturbance depends on the location, and is documented in the Port's underwater noise manual (Ewald and Sloan 2011, Appendix C). Only those projects in the marine environment and EWW or WWW would be expected to produce noise that could disturb SR killer whales. Underwater noise from projects in the Duwamish Waterway would attenuate prior to reaching waters where SR killer whales would be expected.

It is exceedingly unlikely that SR killer whales would occur in areas within range of potential injury from noise, and work would stop per the project-specific marine mammal monitoring plan if they were observed. It is unlikely that their approach would go undetected. It is possible that SR killer whales could occur in areas where project noise exceeds the disturbance threshold. This occurrence is expected to be relatively rare since SR killer whales only occasionally occur in Elliott Bay and waters near the Shilshole marina, typically in fall months, when they are following salmon runs (71 FR 69054). Therefore, in-water work windows for the protection of salmon will also help minimize potential for disturbance of SR killer whales. Marine mammal monitoring will be conducted for pile extraction and installation in marine waters, and work will stop if SR killer whales are observed within the potential disturbance area. Since the disturbance thresholds would only be exceeded across a relatively small portion of Elliott Bay and Puget Sound, along the east side only of Puget Sound, the noise disturbance would not present a barrier to migration. Due to the infrequent use by killer whales of Elliott Bay and Puget Sound in the project vicinity, the very small injury areas, and the implementation of marine mammal monitoring, the potential to disturb SR killer whale is insignificant.

5.3.2 Indirect Effects

Chinook salmon are a primary preferred prey of SR killer whales (Hanson et al. 2010). To the extent that the proposed project affects Chinook salmon populations, it has the potential to also affect prey resources for SR killer whale. As described above, this program will improve conditions for juvenile Chinook salmon relative to the baseline. Given the predominantly beneficial effect to Chinook salmon, potential indirect effects to SR killer whales through Chinook salmon prey would be insignificant or beneficial.

5.4 Humpback whale

5.4.1 Direct Effects

Potential direct effects to humpback whale are the same as those described for SR killer whale. Humpback whales rarely occur within Elliott Bay or Puget Sound within the Action Area. As a result of this and the implementation of a marine mammal monitoring plan, potential direct effects to humpback whales are discountable.

5.4.2 Indirect Effects

No indirect effects to humpback whales are anticipated.

5.5 Marbled murrelet

5.5.1 Direct Effects

The replacement of sheet pile bulkheads and the removal of derelict piles at or immediately waterward of the bankline will result in underwater noise that could affect foraging marbled murrelets. Marbled murrelets may occur in the marine nearshore environment; however, as noted in Section 3.2.6, given the highly urbanized environment within the Action Area, with significant commercial vessel traffic and limited availability of forage fish, marbled murrelets are unlikely to be present. To the extent that they do occur within the Action Area, underwater noise generated from impact pile driving may injure or disturb foraging marbled murrelets. The injury threshold for impact driving of steel sheet pile is exceeded within 117 m of noise-generating activity, and the disturbance threshold is exceeded within 1,166 m of the activity. In order to minimize the potential that project activities could affect foraging marbled murrelets, the Port proposes to conduct an appropriate level of biological monitoring for the protection of marbled murrelets during impact pile driving in the marine zone. The Port proposes to discuss details of the monitoring program with USFWS prior to and during the consultation process to arrive at a mutually agreed upon monitoring plan. Based on the expected rarity of the species in the Action Area and the implementation of a marbled murrelet monitoring plan for projects with potential impacts, the noise effect of the proposed project on marbled murrelets is considered insignificant.

5.5.2 Indirect Effects

As noted above, marbled murrelets forage in nearshore areas on forage fish species. To the extent that the proposed project supports forage fish spawning areas, there is the potential to improve the availability of prey resources in the vicinity. On Port properties, Terminal 5 is the one area with potential forage fish spawning habitat, although no forage fish spawning has been documented there. Potential activities, such as riparian planting in the backshore area, which could occur under this project have the potential to support forage fish spawning habitat, and indirectly, marbled murrelet foraging.

5.6 Bocaccio rockfish

5.6.1 Direct Effects

Potential direct effects to bocaccio are similar to those discussed above for salmonids in the marine and estuarine environment. Because juvenile bocaccio are commonly found in shallow

water habitats, they are more susceptible to potential effects from nearshore projects than adult bocaccio. Juvenile bocaccio could occur within marine portions of the Action Area, although suitable settlement habitat on Port-controlled properties is limited due to the predominance of hard shoreline stabilization.

Water quality

Turbidity

Project activities involving grading, excavation, or fill in or adjacent to waterbodies have the potential to contribute to temporary increased turbidity in adjoining waters.

Similar to salmonids, high levels of total suspended solids (TSS) could adversely affect juvenile bocaccio. To minimize adverse effects of turbidity, conservation measures will be implemented, such as temporary erosion and sediment control measures, work in the dry to the extent feasible, work area isolation, and the use of sediment curtains. Finally, a programmatic Water Quality Monitoring and Protection Plan has been prepared, which establishes procedures and thresholds for water quality monitoring and protection. If those thresholds are exceeded, work will stop and the activity will be modified to ensure that water quality standards are met.

pH

Uncured concrete can harm aquatic invertebrates and fish by increasing pH of adjacent waters. The repair and maintenance activities allowed under this programmatic permit will avoid cured-in-place concrete to the extent feasible. Where cured-in-place concrete is needed, the project will avoid potential impacts from exposure to uncured concrete by allowing concrete to set prior to removal of forms and exposure to seawater.

Other

Several Port-controlled properties are within areas with known soil and/or groundwater contaminants. Prior to conducting project actions, the Port will coordinate with appropriate agencies (EPA and Ecology) at MTCA and CERCLA sites to address proper methods of containing contaminants.

Shallow water habitat

As described in Section 3.2.7, juvenile bocaccio may settle in shallow, intertidal marine habitats, including rocky, cobble, and sand substrates with or without eelgrass or kelp before moving to deeper waters. These types of habitat are presently limited on Port-controlled banklines; however, bankline repair and maintenance under this programmatic permit will require the use of alternative stabilization and ecological enhancement to the extent feasible to increase shallow water habitat opportunity and enhance habitat functions. In many cases, the project will maintain a structurally stabilized shoreline, as necessitated by water-dependent uses, yet over time, shallow water habitat functions are expected to improve through an increase in riparian vegetation, increased shoreline complexity, and expansion of natural shallow water habitats,

relative to baseline conditions. In the short-term, individual project activities have the potential to affect vegetated shallow water habitat through temporary shading effects, turbidity, and disturbance. These temporary disturbances are not expected to result in permanent adverse impacts to shallow water habitats because this programmatic permit does not allow expansion of shoreline stabilization.

Noise

The replacement of sheetpile bulkheads and the removal of derelict piles at or immediately waterward of the bankline will result in underwater noise that could affect bocaccio. The potential extent of disturbance depends on the location, and whether impact driving (installation only) is required. As indicated in the Port's underwater noise manual (Ewald and Sloan 2011, Appendix C), underwater noise generated from vibratory removal of derelict piles and installation of sheet piles would not exceed 171 dB_{RMS}, which is below the injury threshold for fish, including bocaccio, but above the behavioral disturbance threshold. In the instances where sheetpile replacement is proposed, the potential for injury from cumulative sound exposure exists within 251 m (Ewald and Sloan 2011, Appendix C) of the project activity (this assumes 24" steel sheet pile). This injury potential would be limited to relatively brief periods of impact pile driving. Pile removal and replacement will occur during approved in-water work periods when listed salmonids are least likely to be present. Sheet piling will be installed with a vibratory device whenever possible. An impact hammer may be used to proof piles, if needed. Given the limited use of impact pile driving and the limited likelihood of bocaccio presence near sheetpile-armored banklines, the effect of underwater noise on threatened salmonids is expected to be insignificant.

Fish removal/exclusion

Where work area isolation is needed, and where such isolation cannot be accomplished in the dry (during low tide), fish exclusion and removal efforts will be necessary. This may include herding fish out of the work area using large seine nets, or capturing fish using a seine and relocating them outside of the work area if herding is not possible. These activities have the potential to result in harassment or injury of herded or captured fish. Best management practices will be employed to minimize injury to any fish that are encountered (whether listed or not). As such, it is unlikely that any listed species would be encountered during fish removal and exclusion activities, and if they were encountered, best practices would minimize harassment or injury resulting from the activity.

Direct mortality

Given the rarity of juvenile bocaccio at Port bankline sites, the potential that for direct mortality as a result of project activities is discountable.

5.6.2 Indirect Effects

No indirect effects to bocaccio are anticipated.

5.7 Yelloweye rockfish

5.7.1 Direct Effects

Yelloweye rockfish do not typically occur in shallow water habitats. Therefore, potential effects to yelloweye rockfish are limited effects from underwater noise. As discussed above for salmonids and bocaccio, the potential from injury from underwater noise would only exist where replacement sheet piles are proofed using impact pile driving. The maximum distance for potential injury from impact pile driving is 251 m. It is unlikely that yelloweye rockfish would be present in habitats within 251 m of project activities because they prefer habitats at least 30 m deep and because the 100-foot depth contour is approximately 50 to 400 m from potential project activities in Elliott Bay. Behavioral disturbance from impact pile driving activity could extend up to 1,166 m from the activity, which could extend into depths and habitats where yelloweye rockfish could be present. Any effects would be temporary during brief periods of impact pile driving, and effects would be limited to behavioral disturbance, which may include delayed foraging or temporary relocation. Such temporary behavioral effects are considered insignificant.

5.7.2 Indirect Effects

No indirect effects to yelloweye rockfish are anticipated.

5.8 Cumulative Effects

For purposes of consultation under the ESA, cumulative effects entail the effects of future activities not involving federal activities that are reasonably certain to occur within the action area of an action subject to consultation (50 CFR §402.02). Cumulative effects are defined differently for purposes of the National Environmental Policy Act (NEPA).

In general, any and all in-water activities will require federal permits. Upland activities on Port properties will continue to support water-dependent activities, and the specific nature of those activities may change over time depending on the lease-holder. The population of the surrounding area of the City of Seattle continues to increase, along with development and redevelopment pressures. Any plans for activities subject to local, but not federal, regulation would need to comply with all applicable ordinances governing construction, stormwater management, and soil disturbance near water. These regulations are becoming increasingly restrictive to the benefit of sensitive fish and wildlife and water quality.

Section 6. Effects to Critical Habitat

6.1 Chinook Salmon

Critical habitat was designated for the Puget Sound Chinook salmon DPS on 2 September 2005 (70 FR 52630) and it includes the Green River and Lake Washington sub-basins, including the Duwamish Waterway and Elliott Bay. Critical habitat includes areas with physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Primary constituent elements of Chinook salmon critical habitat are listed as:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Project activities that introduce or remove physical elements to and/or from designated critical habitat, or that contribute to short-term changes in water quality, may alter certain primary constituent elements (Table 9).

Table 9. Assessment of primary constituent elements for Chinook salmon.

Primary Constituent Elements	Direct, Indirect, Interrelated and Interdependent Effects
1. Freshwater spawning	Not applicable since Chinook salmon do not spawn in the Lake Washington ship canal.
2. Freshwater rearing	Port properties in the Lake Washington Ship Canal are highly altered, offering no shallow water habitat and little rearing habitat potential. Due to the highly modified shoreline conditions and active maritime industrial use of the sites, bank conditions at Port properties along the Lake Washington Ship Canal are unlikely to be modified significantly. The proposed project may temporarily increase turbidity during construction activities. Impacts will be minimized appropriately by following the conservation measures and timing restrictions mentioned previously.
3. Freshwater migration	Juvenile and adult Chinook salmon migrate past the project site. The proposed project may result in temporary elevated turbidity during project activities. Impacts will be minimized by following the conservation measures and timing restrictions mentioned previously.
4 and 5. Estuarine and marine areas	The proposed project may temporarily increase turbidity during construction activities. Impacts will be minimized appropriately by following the conservation measures and timing restrictions mentioned previously. This programmatic permit will require the use of alternative stabilization and ecological enhancement to the extent feasible to increase shallow water habitat opportunity and enhance habitat functions. Overall, the project will improve conditions relative to the baseline; however, because the program may also include in-kind replacement of vertical bulkheads, there is the potential to adversely affect juvenile Chinook salmon rearing habitat through program actions.
6. Offshore marine areas	Not applicable since the project will not affect offshore marine habitats.

As described in Table 7, the Program will not result in long-term adverse impacts to critical habitat. Instead, the programmatic permit approach is expected to support habitat enhancements for Chinook salmon. However, since the Program may include in-kind replacement of vertical bulkheads, there is the potential to adversely affect juvenile Chinook salmon rearing habitat through program actions. Given the direct, indirect, interrelated, and interdependent effects from the proposed action, the proposed project may affect, and is likely to adversely affect the critical habitat of the Puget Sound Chinook salmon DPS.

6.2 Steelhead

Steelhead critical habitat within the action area includes all areas waterward of OHW in the lower Duwamish River. The Lake Washington Ship Canal is excluded due to economic considerations and marine areas are also excluded. The PCEs of steelhead critical habitat are the

same as those described above for Chinook salmon. Since the Lake Washington Ship Canal and marine areas are excluded from steelhead critical habitat, PCEs 1-3, 5, and 6 would not be affected by the project. As it relates to PCE 4, estuarine areas, the proposed project may temporarily increase turbidity during construction activities. Impacts will be minimized appropriately by following the conservation measures and timing restrictions mentioned previously. Additionally, this programmatic permit will require the use of alternative stabilization and ecological enhancement to the extent feasible to increase shallow water habitat opportunity and enhance habitat functions. Given the direct, indirect, interrelated, and interdependent effects from the proposed action, the proposed project may affect, but is not likely to adversely affect the critical habitat of the Puget Sound steelhead DPS.

6.3 Bull Trout

Bull trout critical habitat includes the following primary constituent elements (excerpted from the final rule, 75 FR 63898):

(1) Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

(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.

(3) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

(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.

(5) Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

(6) In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

(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.

(8) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

(9) Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Project activities that introduce or remove physical elements or that contribute to short-term changes in water quality may alter certain primary constituent elements (Table 8).

Table 10. Assessment of primary constituent elements for bull trout.

Primary Constituent Elements (PCEs)	Direct, Indirect, Interrelated and Interdependent Effects
1. Spring, seeps, groundwater sources and subsurface water connectivity	Not applicable. The project would have no effect on groundwater sources or connectivity.
2. Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering and foraging habitats	The proposed project may result in temporary elevated turbidity during project activities. Impacts will be minimized by following the conservation measures and timing restrictions mentioned previously. The proposed project would not create any barrier to migration, particularly as bull trout are not generally oriented near the shoreline.
3. Abundant food base	The project may result in improved forage base through the enhancement of nearshore habitats that support potential prey species. Short-term water quality impacts would not have noticeable effects on the bull trout food base.
4. Complex stream channel	Generally not applicable. The aquatic habitat in the Action Area does not contain stream habitat features. However, the additional of large woody debris, marshes, and mud flats will contribute to estuarine habitat complexity.
5. Water temperature	Not applicable. This PCE applies mainly to stream habitat, in particular spawning and rearing habitat, and is not applicable to the project's Action Area. Further, the project will not affect water temperature.
6. Spawning Substrate	Not applicable since bull trout do not spawn in the Action Area.
7. Natural hydrograph	The project would have no effect on the natural hydrograph.
8. Permanent water of sufficient quantity and quality such that normal reproduction, growth and survival are not inhibited.	Potential temporary water-quality impacts are possible as a result of sediment disturbance during construction, including bulkhead repair and debris removal. However, these impacts would be minor, temporary, and localized. Impacts would be minimized by following the conservation measures and timing restrictions mentioned previously.
9. Few or no nonnative predatory, interbreeding, or competitive species	The proposed project would not increase populations of any predatory, interbreeding or competitive species.

Given the direct and indirect effects from the proposed action described above, the proposed project may affect, but is not likely to adversely affect, the critical habitat for the Coastal-Puget Sound bull trout DPS.

6.4 Southern Resident Killer Whales

The action area includes designated critical habitat for SR killer whales, which are those areas at depths of 20 feet or more below MHHW that are "occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection" (71 FR 69054). The action area includes Puget Sound (Area 2) (71 FR 69054). Primary constituent elements of proposed critical habitat for the killer whale are listed as:

- Water quality to support growth and development;
- Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and
- Passage conditions to allow for migration, resting, and foraging.

Project activities that contribute to short-term changes in water quality, affect prey species, or interfere with whale movement may alter certain primary constituent elements. For the proposed project, these include temporary turbidity and effects to prey (Chinook salmon).

Table 11. Assessment of Primary Constituent Elements for Southern Resident Killer Whale

Primary Constituent Elements (PCEs)	Direct, Indirect, Interrelated and Interdependent Effects
1. Water quality	The proposed project would affect nearshore marine areas through potential temporary construction impacts as described previously, including short-term increases in turbidity in the immediate vicinity of the project.
2. Prey species	Relative to the existing condition, the baseline will be improved for prey species by enhancing bankline conditions through riparian habitat and the use of alternative bankline stabilization.
3. Passage	The proposed project would not affect passage conditions with the possible exception of during pile-driving activities when project–related noise may cause the whales to relocate if they are present in the area. The potential to disturb SR killer whales is reduced by the implementation of marine mammal monitoring during pile driving activities. In the long term, the duration and nature of activities at Port properties would not change as a result of the project, so the long-term baseline will remain the same.

Given the direct, indirect, interrelated, and interdependent effects from the proposed action, the proposed project may affect, and is likely to adversely affect critical habitat for the SR killer whale due to noise disturbance.

6.5 Bocaccio and Yelloweye Rockfish

Critical habitat for bocaccio includes both nearshore (<30 m) and deepwater (>30 m) areas. Critical habitat for yelloweye rockfish includes only deepwater habitats (>30 m).

Characteristics of deepwater critical habitat for both species include the following:

1. Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities,
2. Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities, and
3. The type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

Characteristics of nearshore critical habitat for bocaccio include the following:

1. Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and
2. Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

Project activities that introduce or remove physical elements or that contribute to short-term changes in water quality may alter certain primary constituent elements (Table 12).

Table 12. Assessment of Primary Constituent Elements for Bocaccio and Yelloweye Rockfish

Critical Habitat Zone	Primary Constituent Elements (PCEs)	Direct, Indirect, Interrelated and Interdependent Effects
Deepwater (bocaccio and yelloweye rockfish)	1. Prey Species	Relative to the existing condition, the baseline may increase prey species abundance, particularly if prey species use shallow water. Prey species would be affected by enhanced bankline conditions through riparian habitat and the use of alternative bankline stabilization.
	2. Water quality	The project will not affect water quality in waters >30 m.
	3. Structure and rugosity	The project will not affect structure or rugosity in waters >30 m.
Nearshore (bocaccio	1. Prey Species	The project may support prey species through enhanced bankline conditions through riparian

Critical Habitat Zone	Primary Constituent Elements (PCEs)	Direct, Indirect, Interrelated and Interdependent Effects
only)		habitat and the use of alternative bankline stabilization.
	2. Water quality	The proposed project may affect nearshore marine areas through potential temporary construction impacts as described previously, including short-term increases in turbidity in the immediate vicinity of the project.

Given the direct, indirect, interrelated, and interdependent effects from the proposed action, the proposed project may affect, but is not likely to adversely affect critical habitat for bocaccio and yelloweye rockfish.

Section 7. Effects Determination

Determination of effects for all the species included in this report and their respective assessment areas are listed in Table 13. The basis for these determinations is summarized below.

Table 13. Determination of Effect

Species	Overall Project Effect	Effect on Critical Habitat
Puget Sound Chinook salmon *Oncorhynchus tshawytscha*	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Puget Sound steelhead *Oncorhynchus mykiss*	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Coastal-Puget Sound bull trout *Salvelinus confluentus*	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Killer whale: Southern Resident *Orcinus orca*	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Humpback whale *Megaptera novaeangliae*	May Affect, Not Likely to Adversely Affect	No Effect
Marbled murrelet *Brachyramphus marmoratus*	May Affect, Not Likely to Adversely Affect	No Effect
Bocaccio *Sebastes paucispinis*	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Yelloweye rockfish *Sebastes ruberrimus*	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Eulachon *Thaleichthys pacificus*	No Effect	No Effect

7.1 Puget Sound Chinook Salmon

The proposed project *may affect* Puget Sound Chinook salmon because they may pass through all portions of the Action Area during their seaward and landward migrations, and because juvenile Chinook salmon are closely associated with nearshore habitats. The project may affect Chinook salmon through temporarily increased turbidity, sound disturbance, shallow water habitat modifications, and direct harassment, injury, or mortality.

The proposed project *is likely to adversely affect* Chinook salmon because:

- the program may affect shallow water habitat through in-kind replacement of vertical bulkheads.

The project will minimize any potential adverse effects as follows:

- conservation measures will be implemented for each project
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited;
- the program will require enhancement and alternative stabilization where feasible to enhance shallow water habitat; and
- shoreline enhancements may support forage fish and invertebrate prey species.

7.2 Puget Sound Steelhead

The proposed project *may affect* Puget Sound steelhead because they may pass through all portions of the Action Area during their seaward and landward migrations. The project may affect steelhead through temporarily increased turbidity, sound disturbance, shallow water habitat modifications, and direct harassment, injury, or mortality.

The proposed project *is not likely to adversely affect* steelhead because:

- juvenile steelhead are not closely associated with nearshore shoreline environments;
- conservation measures will be implemented for each project
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited;
- the program will require enhancement and alternative stabilization where feasible to enhance shallow water habitat; and
- shoreline enhancements may support forage fish and invertebrate prey species.

7.3 Coastal Puget Sound Bull Trout

The proposed project *may affect* coastal-Puget Sound bull trout because they may pass through all portions of the Action Area during their seaward and landward migrations. The project may affect bull trout through temporarily increased turbidity, sound disturbance, shallow water habitat modifications, and direct harassment, injury, or mortality.

The proposed project *is not likely to adversely affect* bull trout because:

- bull trout are rare within the Action Area, and they are not closely associated with nearshore shoreline environments;
- conservation measures will be implemented for each project
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited;

- the program will require enhancement and alternative stabilization where feasible to enhance shallow water habitat; and
- shoreline enhancements may support forage fish and invertebrate prey species.

7.4 Southern Resident Killer Whale

The proposed project *may affect* SR killer whale because they may occasionally pass through marine portions of the Action Area. The project may affect SR killer whales through sound disturbance and effects to prey populations.

The proposed project *is not likely to adversely affect* SR killer whale because:

- a marine mammal monitoring plan will be prepared and implemented during pile driving activities;
- potential for sound to exceed the injury threshold when whales are present is exceedingly unlikely;
- conservation measures will be implemented for each project
- Designated work windows occur when SR killer whales are unlikely to follow migrating salmon into the Action Area; and
- effects to salmon are expected to be insignificant or beneficial since shoreline habitat conditions will be enhanced compared to baseline.

7.5 Humpback Whale

The proposed project *may affect* humpback whale because they may rarely pass through marine portions of the Action Area. The project may affect humpback whale through sound disturbance.

The proposed project *is not likely to adversely affect* humpback whale because:

- a marine mammal monitoring plan will be prepared and implemented during pile driving activities;
- potential for sound to exceed the injury threshold when whales are present is exceedingly unlikely; and
- humpback whales rarely occur within the Action Area.

7.6 Marbled Murrelet

The proposed project *may affect* marbled murrelet because they may rarely occur within nearshore marine portions of the Action Area. The project may affect marbled murrelet through sound disturbance and effects to prey.

The proposed project *is not likely to adversely affect* marbled murrelet because:

- a marbled murrelet monitoring plan will be implemented during impact pile driving activities;
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited ;
- marbled murrelets rarely occur within the Action Area; and
- proposed enhancements associated with repair and maintenance of the Port's banklines may enhance forage fish populations.

7.7 Bocaccio

The proposed project *may affect* bocaccio because they may occur within nearshore and deepwater marine portions of the Action Area. The project may affect bocaccio through temporarily increased turbidity, sound disturbance, shallow water habitat modifications, and direct harassment, injury, or mortality.

The proposed project *is not likely to adversely affect* bocaccio because:

- conservation measures will be implemented for each project
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited;
- the program will require enhancement and alternative stabilization where feasible to enhance shallow water habitat; and
- shoreline enhancements may support forage fish and invertebrate prey species.

7.8 Yelloweye Rockfish

The proposed project *may affect* yelloweye rockfish because they may occur within deepwater marine portions of the Action Area. The project may affect yelloweye rockfish through temporary sound disturbance.

The proposed project *is not likely to adversely affect* yelloweye rockfish because:

- project noised would attenuate before reaching most deepwater marine habitats; and
- sheet piling will be installed with a vibratory device whenever possible, and use of impact pile driving will be limited .

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Appendices

Appendix A. Magnuson Stevens Fishery Conservation and Management Act- Essential Fish Habitat

Appendix B. Marine Mammal Monitoring Plan

Appendix C. Underwater Noise Manual

Appendix A.Magnuson Stevens Fishery Conservation and Management Act- Essential Fish Habitat

Port of Seattle Bankline Repair and Enhancement Program NWS-2018-780-WRD

Magnuson Stevens Fishery Conservation and Management Act- Essential Fish Habitat

December 2018

The Magnuson Stevens Act established procedures to preserve Essential Fish Habitat (EFH) for species regulated under a federal fisheries management plan. Federal agencies are required to consult with the NMFS regarding actions that are authorized, funded, or undertaken by that agency that may adversely affect EFH.

Designated EFH for groundfish and coastal pelagic species encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the MHW line, including the upriver extent of saltwater intrusion in river mouths to the boundary of the U. S. economic zone, approximately 230 miles (370.4 km) offshore.

Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the Pacific Fishery Management Council), and longstanding, naturally-impassable barriers (e.g., natural waterfalls in existence for several hundred years).

In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border.

EFH species are listed below.

Groundfish

- Redstripe rockfish
- Dover sole
- Spiny dogfish
- Rosethorn rockfish
- English sole
- Big skate
- Rosy rockfish
- Flathead sole
- California skate
- Rougheye rockfish
- Petrale sole
- Longnose skate
- Ratfish
- Sharpchin rockfish
- Rex sole
- Pacific cod
- Splitnose rockfish
- Rock sole
- Pacific whiting (hake)
- Striptail rockfish
- Sand sole
- Black rockfish
- Tiger rockfish
- Starry flounder
- Bocaccio
- Vermilion rockfish
- Arrowtooth flounder
- Yelloweye rockfish
- Brown rockfish
- Yellowtail rockfish
- Canary rockfish

- Shortspine thornyhead
- China rockfish
- Cabezon
- Copper rockfish
- Lingcod
- Darkblotch rockfish
- Kelp greenling
- Greenstriped rockfish
- Sablefish
- Pacific ocean perch
- Pacific sanddab
- Quillback rockfish
- Butter sole
- Redbanded rockfish
- Curlfin sole

Coastal Pelagic Species

- Anchovy
- Pacific sardine
- Pacific mackerel
- Market squid

Pacific Salmon Species

- Chinook salmon
- Coho salmon
- Pink salmon

Presence within the Action Area

The presence of EFH within the Action Area is briefly conveyed in the following table.

Table A1. Essential Fish Habitat species within the Action Area

	Groundfish	Coastal pelagic	Pacific salmon
Estuarine- Duwamish Waterway	No	No	Yes
Marine- Puget Sound	Yes	Yes	Yes
Freshwater- Lake Washington Ship Canal	No	No	Yes- Chinook and coho only

Description of the Project / Proposed Activity

The project description and location are described within the first two sections of the BE.

Potential Adverse Effects of the Proposed Project

As described in detail in Section 4, Effects Analysis, the proposed actions (with conservation measures) may result in the following detrimental short and long-term effects on a variety of habitat parameters:

- Temporarily elevated turbidity within 150 feet of project activities
- Temporarily elevated underwater sound during pile driving

In addition to the above potential adverse effects, the project is expected to benefit EFH habitat by enhancing shallow water and riparian habitat.

EFH Conservation Measures

The Port has created a checklist of general and treatment-specific conservation measures that will help ensure that adverse effects resulting from the selected design treatment are avoided and minimized to reduce the collective impact on EFH. A description of all conservation measures is included in Attachment C.

Conclusion

All of the proposed project's potential impacts on EFH are considered collectively. Potential adverse impacts have been avoided and minimized. Thus, the proposed project would not adversely affect Pacific groundfish, coastal pelagic, or Pacific salmon EFH.

Appendix B. Marine Mammal Monitoring Plan

Port of Seattle Bankline Repair and Enhancement Program NWS-2018-780-WRD

Marine Mammal Monitoring Plan

December 2018

Introduction

The Port of Seattle (Port) proposes to conduct bankline repair and enhancement activities, which may involve replacement of steel sheet pile and removal of derelict piles at or immediately waterward of the bankline. The bankline repair and enhancement program applies to the Port's 29 bankline properties (Attachment F). Three of those sites occur in freshwater, where underwater noise will not affect marine mammals. Some of the remaining 26 sites will not require monitoring because of the nature of activity proposed and the location. The only piles that would be installed under this permit would be the replacement of sheetpile. Removal of derelict piles is expected to occur on an occasional basis. Most derelict piles on Port banklines are less than 24 inches diameter, and they are typically made of creosote-treated wood.

Noise levels during vibratory and impact pile installation and vibratory pile removal could exceed the noise thresholds the National Marine Fisheries Service (NMFS) has established for underwater disturbance of marine mammals within portions of the action area at each of the 24 estuarine and marine sites. The Biological Assessment prepared for this project states that a marine mammal monitoring plan will be implemented during pile removal or installation to avoid impacts to southern resident (SR) killer whale (*Orcinus orca*) and humpback whale (*Megaptera novaeangliae*). The areas in which monitoring is proposed in this plan are dependent upon the location and type of activity conducted (vibratory removal and/or installation or impact installation).

Discussion

Noise from impact pile driving of sheetpile falls below the injury threshold for cetaceans (180 dB_{RMS}) within 12 m of the noise-generating activity. Noise from vibratory pile installation and extraction does not exceed the injury threshold for marine mammals. Underwater noise from vibratory and impact driving can exceed the behavioral disturbance thresholds (ambient and 160 dB_{RMS}, respectively) a maximum distance of 2,154 m based on the loudest vibratory installation of 24" steel sheet pile. The distance of sound disturbance from removal of derelict wood piles or steel piles 12" or less in diameter would be lower than from sheet pile (see Appendix C).

Species Presence

SR killer whale and humpback whale may occur within marine portions of the Action Area, as described in the biological assessment. Underwater sound from projects within the Lower

Duwamish River will attenuate prior to reaching marine waters due to reflection off of structures and land features. Sound effects from projects in the East and West Waterways may extend into narrow areas of marine environment, where disturbance effects could occur. Projects in the marine portions of the Action Area have the greatest potential to disturb SR killer whale and humpback whale.

Monitoring Areas (Vibratory and Impact Pile Replacement and Removal Activities)

During any vibratory pile removal or installation conducted at sites where underwater sound could reach the marine environment, the Vibratory Monitoring Area within the 120 dB_{RMS} Vibratory Temporary Effect Area will be monitored and maintained as a marine mammal buffer area. Vibratory pile removal or installation will not commence or will be suspended temporarily if any SR killer whale or humpback whale is present within the Vibratory Monitoring Area.

Similarly, at sites where impact pile installation could potentially affect orca or humpback whale, the respective Impact Monitoring Area within the 160 dB_{RMS} Impact Temporary Effect Area will be will be monitored and maintained as a marine mammal buffer area. Impact pile installation will not commence or will be suspended temporarily if any SR killer whale or humpback whale is present within the Impact Monitoring Area.

Monitoring Protocol

The Port will conduct the following marine mammal monitoring activities at the locations and during the activities described above under Monitoring Areas:

1. Qualified biologists or other trained marine mammal observers who meet the following qualifications for marine mammal observers will be present on site at all times during pile removal/driving activities.
    a. Visual acuity in both eyes (correction is permissible) sufficient to discern moving targets at the water's surface and to estimate target size and distance. Use of binoculars may be necessary to identify the target correctly.
    b. Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience).
    c. Experience or training in the field identification of marine mammals (cetaceans and pinnipeds).
    d. Sufficient training, orientation, or experience with the construction operation to preserve personal safety during observations.
    e. Writing skills sufficient to prepare a report of observations that would include such information as the number and type of marine mammals observed; the behavior of marine mammals in the project area during construction, dates and

times when observations were conducted; dates and times when in water construction activities were conducted; dates and times when marine mammals were present at or within the defined disturbance zone; dates and times when in water construction activities were suspended to avoid incidental harassment by disturbance from construction noise; etc.

f. Ability to communicate orally, by radio or in person, with project personnel to provide real time information on marine mammals observed in the area as necessary.

2. Qualified biologists will be stationed at observation stations that are adequate to clearly view the outer boundaries of the Action Area as identified on the appropriate Action Area map. Typical monitoring stations are identified in Figure B-1. Maps showing the area of marine mammal disturbance are included in Appendix C of the programmatic permit submittal; an example map is included as Figure B-2.

3. If a vessel is required to adequately monitor the Action Area, a GPS will be used to accurately position the vessel at its observation station or transect.

4. Assigned biologists will contact the Orca Network (1-866-672-2638) before vibratory pile driving and removal work begins each day to get an update on the latest SR killer whale sightings data. The observer(s) will use binoculars (Vector 10 x 42 or equivalent) and visual observation to scan the waters within the respective Monitoring Area.

5. The observer(s) will scan the waters 20 minutes before the beginning of pile removal/driving activities and during all pile removal/driving activities. If SR killer whale(s) or humpback whale(s) enter or are observed within the respective Monitoring Area during or 20 minutes prior to pile driving, the biologists will notify the on-site Port of Seattle inspector and the inspector will require the contractor to not initiate or temporarily cease work until the animal(s) has moved outside of the Monitoring Area.

6. If weather or sea conditions restrict the observer's ability to observe, or become unsafe for the monitoring vessel(s) to operate, pile installation or removal will cease until conditions allow for monitoring to resume.

7. Pile driving will occur only during daylight hours when you can visually monitor marine mammals.

8. The species, date, and time of any marine mammal sightings will be recorded. Marine mammal behavior and any communication between the observer and the contractor during pile driving will also be recorded.

9. If any dead or dying marine mammal species are observed in the action area, regardless of known cause:
    a. the species type (if known), date, time, and location of the observation will be recorded,
    b. the specimen will be photographed, and
    c. NOAA Fisheries will be notified immediately.

Documentation

All projects that require marine mammal monitoring shall be required to produce a written plan prior to construction that outlines a monitoring strategy consistent with these specifications. Following construction, a written report shall be drafted that summarizes the monitoring conducted for the project. Monitoring reports shall be maintained by the Port for the duration of the programmatic authorization (10 years) and made available upon request.

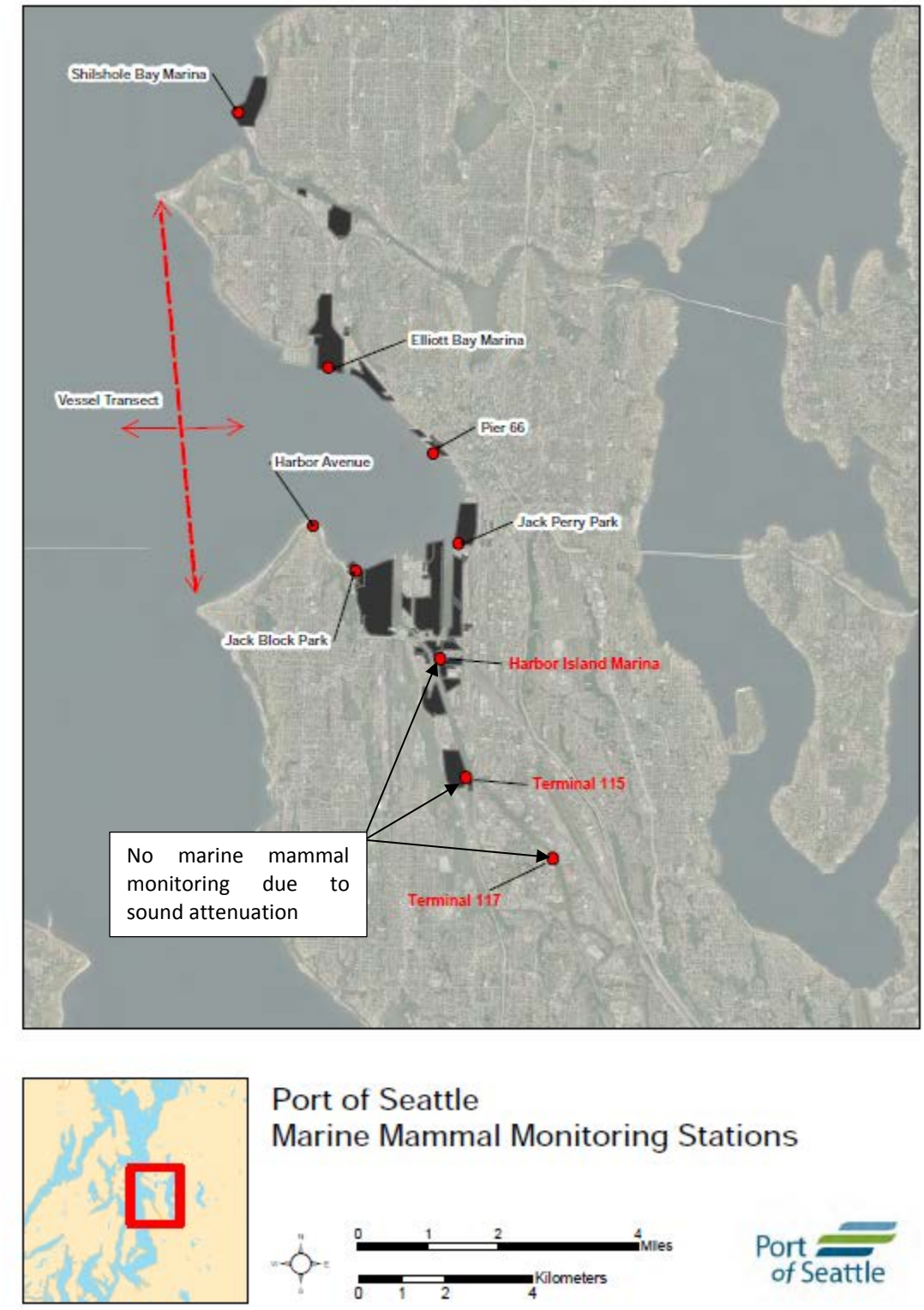

Figure B-1. Marine mammal monitoring stations

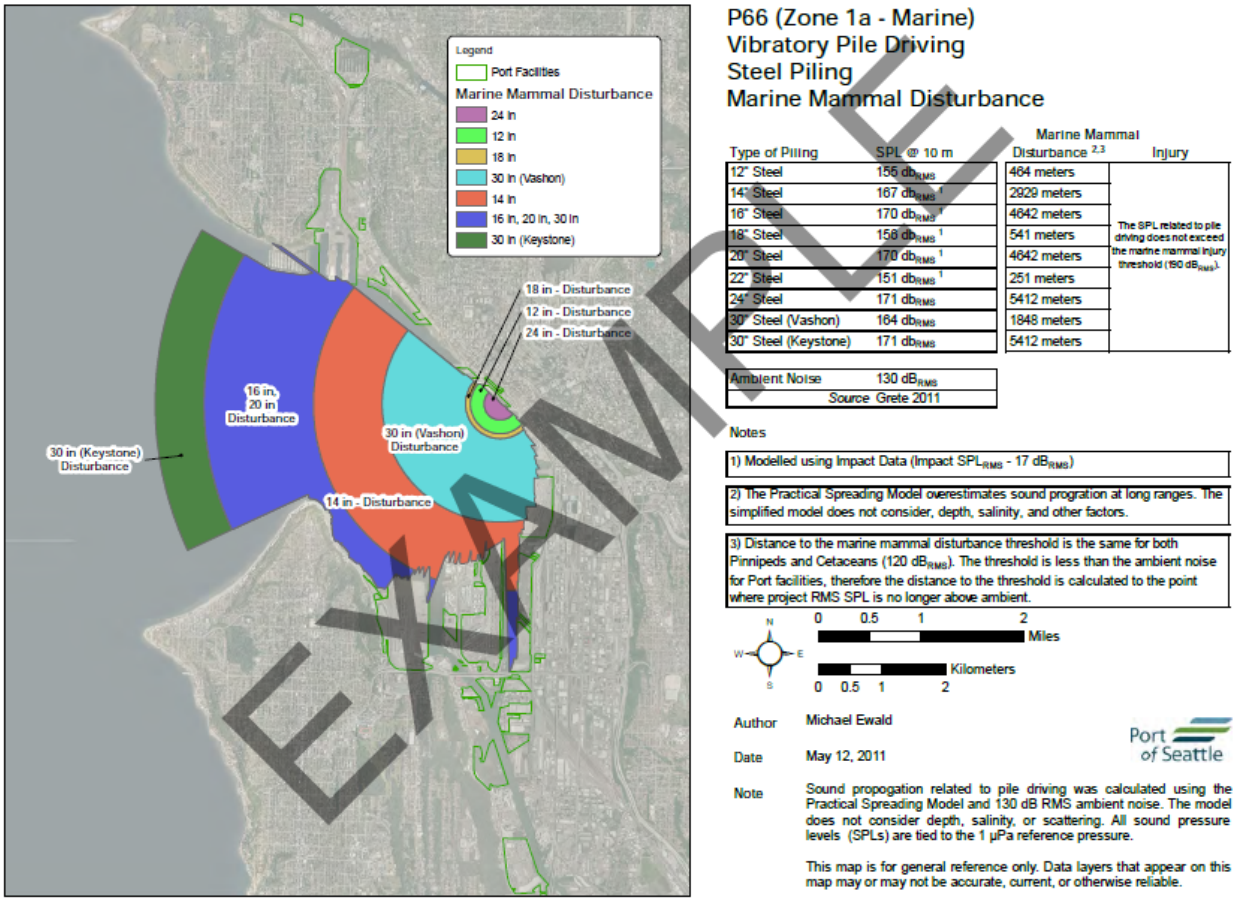

Figure B-2. Example marine mammal disturbance area figure

References

Ewald, M. and J. Sloan. 2011. Modeling Underwater Noise Associated with Pile Driving Activities. Port of Seattle. Included as Appendix C of this report.

Appendix C. Modeling Underwater Noise Associated with Pile Driving Activities (Ewald and Sloan 2011)

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Modeling Underwater Noise Associated with Pile Driving Activities

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Introduction

The Port of Seattle routinely engages in pile driving activities to support the continued operations of its facilities. This document presents the Port's approach to modeling underwater noise related to pile driving and identifies hydro-acoustic data gaps and common method pitfalls. The modeling approach and the scenarios presented in this document will be used to support the Port's permitting efforts for routine pile driving projects.

The Port's approach draws heavily on the work of the Washington State Department of Transportation ("WSDOT") and the California Department of Transportation ("Caltrans"), which have spent considerable effort addressing issues related to underwater construction noise. These organizations have compiled guidance documents, funded academic investigations, and continue to collect hydro-acoustic monitoring data. The 2009 Caltrans guidance document prepared by ICF Jones & Stokes and Illingworth and Rodkin, Inc. provides a strong background on the issue of underwater noise related to pile driving. WSDOT also prepared a guidance document for its biological assessment staff that covers underwater construction noise related to pile driving in Washington waters. For in-depth introductions to underwater noise assessment and pile driving installation methods, the WSDOT and Caltrans manuals provide excellent references.

This manual is divided into three sections. The first section provides a very brief introduction to underwater acoustics related to pile driving. The second section describes how the Port's analysis was performed. The final section presents the results of the Port's modeling effort. Maps attached as an appendix to this document depict where various underwater noise thresholds are predicted to occur in relation to worst-case potential project location at each Port facility.

Environmental Setting

The Port's facilities are set within highly-modified maritime industrial areas and urban waterways. These facilities are primarily committed to maritime industrial, cargo, cruise, recreational and commercial moorage, and other water-dependent or water-related commercial uses. Properties adjacent to the Port's facilities generally share a similar setting and support similar uses. These uses include transportation facilities, maritime industrial facilities, and moorage.

Existing environmental conditions reflect modifications associated with current and historic commercial uses. The shoreline area is typically dominated by over-water piers, riprap slopes, constructed seawalls, and bulkheads. Subtidal areas are typically dredged to between 15 feet (4.6 m) and 50 feet (15 m) to provide sufficient depth for commercial vessel operations. Sand, silt, and mud are the dominant substrate

types. Ambient noise near the Port's facilities is estimated to be approximately 128 dB_{RMS}-130 dB_{RMS} (Grette and Associates, LLC. 2010; Laughlin 2011).

Typical Pile System Repair and Maintenance

Pile system repair and maintenance activities typically include the replacement of structural, fender, dolphin, float, and/or other types of piles typically ranging in size between 12" and 30" in diameter. Pile materials include wood, steel, concrete, HDPE plastic, and others. Pile systems also include fender components, cathodic protection, rub strips, and pile caps.

Typically, vibratory and/or mechanical impact methods stationed on a barge, derrick, or landside crane will be used to remove or install piling. Impact pile drivers force a pile into the substrate using a heavy weight that repeatedly strikes the pile, much like using a hammer to strike a nail. This method can produce high peak sound pressure levels that can injure fish and other organisms. For this reason, noise mitigation strategies have been developed including bubble curtain devices and other barriers that slow or reduce the propagation of underwater noise related pile driving (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010).

Another installation method is vibratory pile driving. The vibratory hammer uses continuously oscillating weights that shake a pile, liquefying adjacent substrate, and pressing the pile to depth. Vibratory pile drivers typically produce lower sound pressure levels than impact hammers and have become the Port's preferred installation method. The National Oceanic and Atmospheric Administration (NOAA) has classified vibratory pile drivers as continuous noise and therefore an important consideration when evaluating the impact of any project on marine mammal species. Both installation methods and noise reduction strategies for each of them will be described in more detail later in this manual.

The Port performs all in-water construction within work windows established by the Corps of Engineers through consultation with NOAA and U.S Fish and Wildlife Service (USFWS). In-water construction windows are intended to concentrate work during periods when listed fish species, including Chinook salmon and bull trout, are generally not present in the project area due to their seasonal life history patterns. Other listed fish and wildlife, including marine mammals and avifauna, are less predictable with respect to seasonal presence/absence. To insure these taxa are not impacted, trained personnel are engaged to monitor a pre-determined action area and stop work if necessary. The Port follows all permit conditions and has a robust compliance tracking system to ensure and document permit compliance.

Fundamentals of Underwater Noise Assessment

Underwater acoustics is a highly complex science and this section is intended only to provide a very basic introduction. For a more in-depth introduction to underwater acoustics please review the 2009 Caltrans guidance manual prepared by ICF Jones & Stokes and Illingworth and Rodkin, Inc.

Sound is emitted by the vibration of materials in a medium such as air or water. This vibration produces a sound wave that travels away from the source, known as acoustic radiation. In the case of pile driving activities, the piling vibrates as it's struck with an impact hammer or installed using a vibratory hammer. This noise radiates away from the piling and may cause harm if received by a species at sound levels within the auditory range specific to that species, called an audiogram.

Much of the research related to pile driving has focused on peak sound pressure levels received at close ranges (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). This is the result of more then a decade of research investigating the effects of impact pile driving on protected fish species, especially salmonids (Feist *et al.* 1996). With increased and recent attention focusing on potential anthropogenic noise impacts to marine mammals, more research has been conducted looking at the

transmission of anthropogenic noises at long ranges with much of the recent research focused on continuous noises produced by the construction and operation of offshore wind and tidal energy facilities as well as vessel noise (Nedwell *et al.* 2003b; Madson *et al.* 2006; Southall *et al*. 2007).

Underwater Noise Prorogation

Underwater noise propagation is highly complex and difficult to predict with certainty. Complex interactions between other sources of natural and anthropogenic sound, substrate, water surface, temperature, and other factors all influence how sound propagates through the water.

Sound can propagate from the source to the receiver either directly, after reflecting off the surface of the water or substrate, or through and reradiated from the substrate. It's likely that underwater sound is actually received from a combination of all of these paths (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). A simplified propagation path diagram is illustrated in Figure 1.

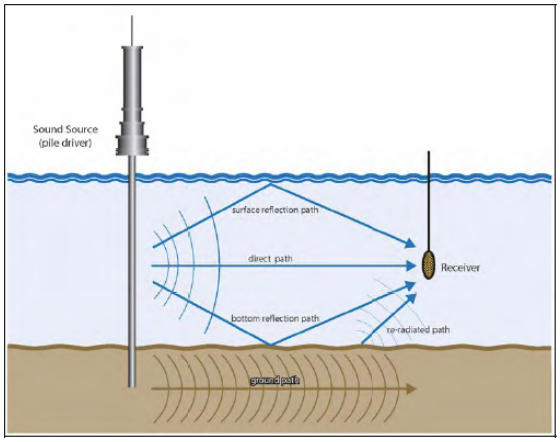

Figure 1: Sound Propagation Paths (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009)

Noise levels are usually expressed as a Sound Pressure Level (SPL) using decibels (dB) as the unit of measure and are tied to a specific reference pressure. A decibel is a logarithmic unit that measures the power or intensity (i.e., amplitude) of a sound pressure wave. For water, the standard reference pressure is one micro Pascal (1 µPa). The standard reference pressure for airborne SPL measurements is 20 µPa. *Within this document, all SPL levels are expressed in decibels (dB) and referenced to 1 µPa unless otherwise noted.*

Hydroacoustic Measurement Metrics

The waveform of underwater noise is typically expressed with three different metrics for the purpose of evaluating underwater noise impacts: Peak, Root Mean Square (RMS), and Sound Exposure Level (SEL). These metrics are illustrated in Figure 2 and described below:

- *Peak sound pressure (dB_{Peak})* — This metric measures the waveform from the node to the crest of the wave. Peak pressure is the maximum absolute value of the instantaneous pressure that occurs during a specified time interval and is usually used for impulsive sounds such as impact pile driving or underwater explosive detonations (WSDOT 2010). Non-auditory tissue damage, injuries such as swim bladder or capillary rupture, is correlated to the received peak pressure (ICF Jones & Stokes, Illingworth and Rodkin, Inc 2009). At sufficiently high received-levels, single events can injure an organism.

- *Root Mean Square (dB_{RMS})* — RMS measures the average sound level over a reference time period. It is calculated by squaring the amplitudes of the waveform over the reference period, determining the mean, and finally calculating the square root of the mean squared values (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009). This metric is typically used when measuring or comparing continuous noises such as ambient noise levels or noise produced by vibratory pile driving equipment.

▪*Sound Exposure Level (db_{SEL})* — SEL is the constant sound pressure level in one second of exposure and is calculated by summing the cumulative pressure squared over the time of the event (WSDOT 2010). A single strike is measured to calculate SEL during impact pile driving while a one second duration is measured during vibratory pile driving.

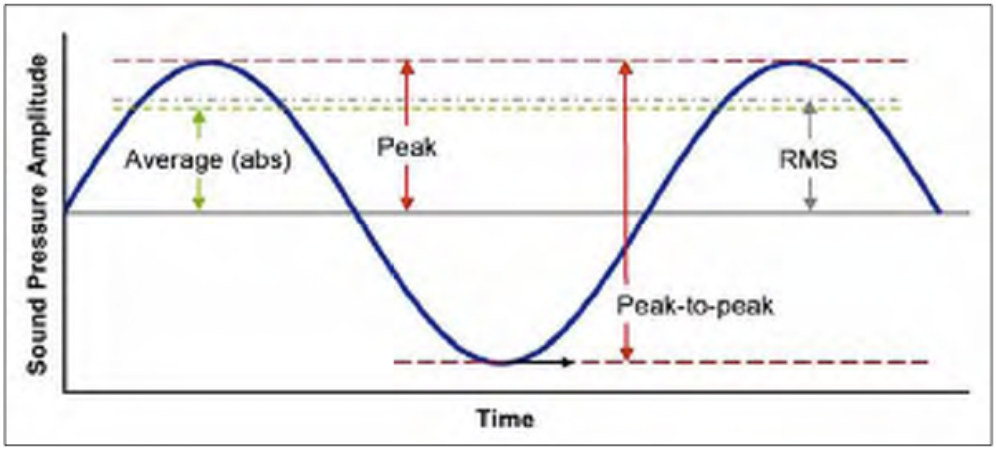

Figure 2: Sound Level Metrics (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009)

Cumulative SEL is a measure used to evaluate the cumulative effects of exposure to impact pile driving. ICF Jones & Stokes and Illingworth and Rodkin, Inc (2009) calculate $SEL_{cumulative}$ using the following equation:

Equation 1: Calculation of $SEL_{cumulative}$
$SEL_{cumulative} = dB_{SEL}+10 \log (\#\ of\ strikes)$

Another metric that can help describe the configuration of an underwater noise signal is rise time. Rise time describes the time period, typically measured in milliseconds, in which the underwater noise signal rises from 10 percent to 90 percent of its highest peak value (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009). Figure 3 illustrates rise time.

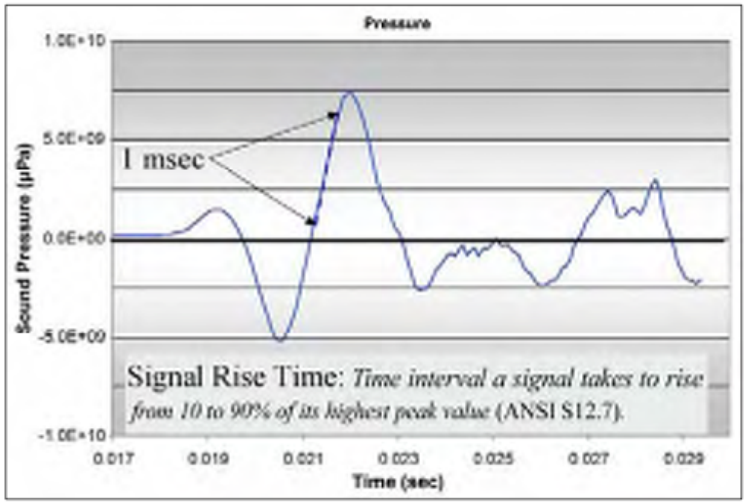

Figure 3: Illustration of Rise Time (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009)

Rise time may be important in describing the shape of the underwater noise waveform. WSDOT (2010) suggest that a slower rise time, and therefore a more spread out shape, may help explain why the use of vibratory pile drivers has not been linked to fish injury. Popper *et al*. (2006) notes that mammalian auditory damage is more likely with "sharp" pulsed sounds as opposed to "dull" sounds, meaning that more damage is likely when the sound has a short rise time. Rise time has not been used as a primary metric for noise

assessment and is typically not discussed in detail as part of monitoring reports (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). The use of different impact and vibratory pile driving equipment, noise attenuation strategies, and other factors would change the signal rise time. We present this metric to illustrate and explain rise time but do not consider it in our analysis as the current noise impact analysis methods suggested by federal resource agencies do not consider it.Audiograms and Frequency-dependent Analysis Bandwidths

Different species "hear" and respond to noise differently (Southall *et al.* 2007; ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). The hearing ability of an organism is frequency dependent, meaning that an organism may have difficulty hearing a certain frequency (e.g., low frequency) while being extremely sensitive at a different frequency (e.g., high frequency). Audiograms visually portray the relationship between frequency (x axis) and hearing ability (y axis).

It is important to note that while thresholds and acoustic measurements for pile driving typically referenced in decibels, two decibel values may not be directly comparable if the analysis bandwidth, the specific range of signal wavelengths selected for analysis, used to calculate the decibel values differ. If part of the signal frequency lies outside of the analysis bandwidth, it is ignored (Burgess *et al.* 2005). For this reason, injury / disturbance thresholds and monitoring data characterizing different types of noise emitted during pile driving activities have relied on broadband analysis bandwidths that cover a wide range of wavelengths (Burgess *et al.* 2005). While this approach simplifies the sound analysis for projects by reducing the number of data points for a given pile type, the measured sound level for the pile driving may be influenced by other sources, not part of the analysis, masking the true influence of the project under consideration (Burgess *et al.* 2005).

Recent monitoring reports published by WSDOT have calculated and reported decibel measurements of ambient noise using three analysis bandwidths that are appropriate for cetaceans, pinnipeds, as well as a broadband measurement (Laughlin 2011). While this may be valuable data for the future, it is not appropriate to compare sound measurements for piling installation collected using a broadband analysis window with ambient noise data collected and analyzed using a narrower analysis bandwidth specific to a particular species. While it is true that two signals of different wavelengths could be compared using decibels (because the decibel measures amplitude), it is not the case with complex noises such as pile driving that span a wide range of wavelengths. By employing an analysis bandwidth, the sound is compressed. The energy that makes up a decibel value using one analysis bandwidth is different and distinct from another analysis bandwidth and not comparable. A sound measured using a broadband analysis bandwidth includes a wide range of frequencies while narrower analysis bandwidths do not. Most monitoring data are collected and reported using a broadband analysis window. Until more data is gathered describing the acoustic properties of pile driving within analysis bandwidths that are appropriate to specific species or hearing groups, sound impact analysis should be performed using a broadband analysis window.

Injury and Disturbance Thresholds

NOAA and others have established thresholds to guide the determination of whether pile driving noise may adversely affect species of concern. The effects depend on the auditory range of a given species (i.e., the range of wavelengths that the species can "hear"), the transmission characteristics of sound within that auditory range, and the harm caused by the received level (Nedwell *et al.* 2007; ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). Injury may be dependent on the mass of an organism, exposure time, species, functional hearing group, and many other factors (Nedwell *et al.* 2007; Carlson *et al.* 2007; WSDOT 2010).

Generally the data that has been collected as part of monitoring efforts does not account for species-specific auditory ranges and instead is collected over a broadband range (ICF Jones & Stokes and

Illingworth and Rodkin, Inc. 2009; WSDOT 2010). Broadband estimates of produced noise allow for the easy application of assessment tools and cover the broad range of frequencies likely to impact species; however, it may not provide an assessment mechanism that accurately predicts harm or disturbance to a species of concern. This is because the thresholds and measured sound levels are not tied to the species-specific auditory range being considered. Additionally, the thresholds established by the agencies are precautionary and may overestimate the distance that sound propagates under water. Care should be taken when compiling data from monitoring reports and other sources to ensure that estimates are comparable.

Impact pile driving produces impulsive noise with higher peak amplitude than the continuous noise produced by vibratory pile driving. While environmental effects of the impulsive noise produced by impact pile driving have been well studied, the effects of continuous lower-amplitude noise produced by vibratory hammers have not (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010; Hastings 2010). At present, however, vibratory hammers are a preferred method on the basis that they produce lower peak sound pressures, have shorter rise time, and are consequently assumed to have less impact on fish (ICF Jones & Stokes and Illingworth and Rodkin, Inc. 2009; WSDOT 2010). This assumption is supported by the fact that there are no indications, anecdotal or otherwise, that vibratory hammers have caused injury or mortality in fish. Despite this, vibratory hammers have come into question recently because of their potential effects on marine mammals, which have a different auditory range and are thus susceptible to underwater noise in a different bandwidth. The specific thresholds for both fish and marine mammals are presented in the tables below.

Table 1: Fish Injury Thresholds: Impact Pile Driving

Effect	Metric	Fish mass (grams)	Threshold
Onset of physical injury	Peak Pressure	All, N/A	206 dB_{Peak}
	Accumulated Sound Exposure Level (SEL)	≥ 2 g	187 $dB_{Cum.\ SEL}$
		< 2 g	183 $dB_{Cum.\ SEL}$
Adverse behavioral effects	Root Mean Square Pressure (RMS)	All, N/A	150 dB_{RMS}

Source: Fisheries Hydroacoustic Working Group (FHWG), 2006. "Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities"

Table 2: Marine Mammal and Marbled Murrelet Thresholds

Species	Underwater Noise Thresholds		
	Vibratory Pile Driving Disturbance Threshold	Impact Pile Driving Disturbance Threshold	Injury Threshold
Cetaceans	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Pinnipeds	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Foraging marbled murrelets	N/A	150 dB_{RMS}	180 dB_{peak}

Source: Washington State Department of Transportation, 2009. "Marine Mammal, Fish, and Marbled Murrelet Injury and Disturbance Thresholds for Marine Construction Activity." <http://www.wsdot.wa.gov/NR/rdonlyres/216F21DA-A91B-43F2-8423-CD42885EE0EC/0/BA_MarineNoiseThrshlds.pdf> (Retrieved Jan 06, 2010)

It should be noted that formal thresholds for the vibratory installation of piling have not been established for fish species and no injury or mortality has been observed, as noted above. Hastings (2010) provides the first study to specifically look at the issue of vibratory pile driving and fish injury but the study is focused on preliminary laboratory experiments using warm-water freshwater species, not salmonid species in cold estuarine environments. For this reason, the Port did not use the Hastings thresholds in its analysis.

The 120 dB_{RMS} continuous noise threshold used by NOAA is a precautionary threshold that is based on a single study. Research done by Southall *et al*. (2007) seems to refute the precautionary threshold, suggesting that industrial noise exposures in the range of 90 dB and 140 dB do not induce strong behavioral responses in pinnipeds. Recognizing this uncertainty, NOAA has undertaken a science-based initiative to establish new thresholds. For the time being, the Port has used the precautionary 120 dB threshold for its analysis.

Underwater Noise Spreading Models

Underwater sound propagation is dependent on many factors including bathymetry, substrate, and salinity (ICF Jones & Stokes 2009; WSDOT 2010). Due to the complex nature of the interaction between these factors and others the development of site-specific models that accurately predict sound propagation is impractical. Estimates of sound propagation rely on empirical data gathered as part of past projects and simplified exponential decay spreading models in an attempt to estimate the effects of projects.

The simplified spreading model is defined in Equation 2 below:

Equation 2: Spreading Loss Model

$$TL = F \bullet Log(R_1/R_2)$$

Where:

- TL is the transmission loss in dB
- F is a site-specific attenuation factor or generalized attenuation estimate. A value of 15 should be used if more specific data is not available.
- R_1 is the range of the SPL
- R_2 is the range at which the SPL measurement was taken, typically 10 meters.

Equation 2 has three commonly used variants. These include:

- Spherical Spreading Model (F = 20),
- Practical Spreading Loss Model (F = 15)
- Cylindrical Spreading Model (F = 10)

The F parameter controls how rapidly sound attenuates in water with higher values representing a more rapid attenuation towards zero. The Microsoft Excel based tool developed by John Stadler and David Woodburry at NOAA in 2009 recommends using an F value of 15 if site-specific data is not available. WSDOT and others refer to an F value of 15 as the Practical Spreading Loss Model (PSLM) and the Port has adopted this terminology and value for its analysis.

Equation 3 rearranges Equation 2 to solve for the distance (R_1) at which a known source sound level is expected to attenuate to a target level, such as one of the thresholds presented in Table 1-2 or an ambient noise value.

Equation 3: Application of the spreading model by solving for R_1
$R_1 = (10^{((dB_{Source} - dB_{Target})/F)})*R_2$ Where: • R_1 is the range at which the source sound attenuates to dB_{Target} • dB_{Source} represents the source SPL at range R_2 • dB_{Target} represents the SPL you are interested in. For example, this value may represent a threshold or ambient noise value. • F is a site-specific attenuation factor or generalized attenuation estimate. A value of 15 should be used if more specific data is not available. • R_2 is the range at which the SPL measurement was taken, typically 10 meters.

Monitoring reports published by WSDOT for piling projects at the Vashon Island Ferry Terminal indicate that the Spherical Spreading Model (F=20) may approximate the attenuation characteristics better than the PSLM (Laughlin 2010b). Bathymetric conditions at the Vashon Island Ferry Terminal are similar to many Port facilities, including Terminal 91 and Pier 66. As more data specific to central Puget Sound is collected by WSDOT, it may be appropriate to select a different F value. However, until more data is gathered or a better model is developed, the Port will rely on the PSLM for its analysis, consistent with the recommendations of NOAA staff and the training manuals developed by Caltrans and WSDOT.

The PSLM and other variants of the simplified model may not be effective in estimating the area affected by a project at distances greater than one kilometer. This is due to additional sources of anthropogenic and natural underwater noise and scattering (WSDOT 2010). While the Caltrans manual suggests limiting the action area to one kilometer if the expected action area exceeds this distance, the Port has chosen to report the values provided by the equation and accepted by the services. The Port feels that while the PSLM likely significantly overestimates the range at which noise associated with pile-driving projects are detectible, specific data is lacking and therefore choosing one kilometer as the cutoff is arbitrary. Instead, appropriate mitigation and/or monitoring efforts may be discussed with the permitting agencies with jurisdiction.

It should be noted that the outputs of the simple propagation models commonly used for noise impact analysis are rough estimates. Care should be taken to avoid the pitfalls of false precision when developing appropriate monitoring and mitigation strategies.

Pile Driving Data Selection and Model Application

This section provides details on how the Port analyzed underwater noise impacts using the thresholds and the PSLM. To ease future analysis for Port projects, and provide an easy tool for others, we adapted and improved the Stadler and Woodburry (2009) spreadsheet. The tool is described within this section and an electronic copy provided with the submittal of this report.

Acoustic Data Selection

Monitoring data from the Caltrans and WSDOT noise assessment manuals, WSDOT monitoring reports, past Port pile driving projects, and other resources were gathered. In situations where multiple data points for a given type, material, and diameter pile were available, the report that best represented the Port's facilities and bathymetric setting was selected. For example, multiple data points for 16 inch steel piling were available. One data point was from California in Illingworth and Rodkin (2009) and the other was from a Washington State Department of Transportation monitoring report. The WSDOT report was

selected because it was gathered locally in Puget Sound in substrate conditions known to be similar. If multiple data points were available and a clear selection could not be made without additional data, both were presented in the table and modeled.

In most cases, data specific to Puget Sound was limited. ICF Jones & Stokes and Illingworth and Rodkin, Inc. (2009) and WSDOT (2010) were the primary acoustic data references. The Ports objective was to compile the most complete and representative list of pile driving scenarios possible given an extensive literature review and available data for each type of piling and both impact and vibratory installation methods. Unfortunately it was impossible to construct a complete vibratory pile driving dataset. To work around this issue, and after consulting with Grette and Associates Inc., comparable impact sound level data was gathered and a 17 dB reduction was applied, consistent with the difference observed between impact and vibratory pile drivers reported in the WSDOT (2010) manual and Nedwell and Edwards (2002).

Tables depicting the sound pressure levels for each type of modeled piling using an impact and vibratory hammer are presented below. In the results section of this document, the modeled distances to each threshold are presented.

Table 3: Impact Pile Driver Acoustic Data

Title	dB_{Peak}	dB_{RMS}	dB_{SEL}	Citation
24" Steel AZ Steel Sheet	205	190	180	Illingworth and Rodkin, Inc. 2007
24" Concrete Pile	194	181	167	Laughlin 2007
36" Concrete	192	176	174	WSDOT 2010
10" Steel H-Pile	190	175	155	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile - Thin	190	175	160	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile - Thick	195	183	170	Illingworth and Rodkin, Inc. 2007
15" Steel H-Pile	195	180	170	Illingworth and Rodkin, Inc. 2007
12" Steel Pile	192	177	-	Illingworth and Rodkin, Inc. 2007
12" Steel	208	191	175	Laughlin 2006
14" Steel Pile	200	184	174	Illingworth and Rodkin, Inc. 2007
16" Steel Piling	200	187	174	Laughlin 2004
18" Steel Pipe	192	173	-	Laughlin 2010d
20" Steel	208	187	176	Illingworth and Rodkin, Inc. 2007
24" Steel	212	189	181	Laughlin 2005a
30" Steel	212	195	186	Laughlin 2005b
36" Steel	214	201	186	Laughlin 2007
12-14" Wood / Timber	180	170	160	Illingworth and Rodkin, Inc. 2007

Table 4: Vibratory Pile Driver Acoustic Data

Title	dB_{Peak}	dB_{RMS}	dB_{SEL}	Citation
24" Steel Sheet Pile - Typical	175	160	160	Illingworth and Rodkin, Inc. 2007
24" Steel Sheet Pile - Loudest	182	165	165	Illingworth and Rodkin, Inc. 2007
24" Concrete [1]	177	164	150	Laughlin 2007
36" Concrete [1]	175	159	157	WSDOT 2010
10" Steel H-Pile	161	147	-	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile	165	150	150	Illingworth and Rodkin, Inc. 2007
12" Steel	171	155	155	Illingworth and Rodkin, Inc. 2007
14" Steel [1]	183	167	157	Illingworth and Rodkin, Inc. 2007
16" Steel [1]	183	170	157	Laughlin 2004
18" Steel [1]	175	156	-	Laughlin 2010
20" Steel [1]	191	170	159	Illingworth and Rodkin, Inc. 2007
24" Steel	157	151	144	Illingworth and Rodkin, Inc. 2010
30" Steel - Keystone	196	171	-	Laughlin 2010a
30" Steel - Vashon	187	164	-	Laughlin 2010c
36" Steel Pipe (Loudest)	185	175	175	Illingworth and Rodkin, Inc. 2007
36" Steel Pipe (Typical)	180	170	170	Illingworth and Rodkin, Inc. 2007
12" Wood / Timber [1]	163	153	143	Illingworth and Rodkin, Inc. 2007

1) Vibratory hydroacoustic data was not available therefore a 17 dB reduction from impact levels was applied (WSDOT 2010; Nedwell and Edwards 2002).

Noise Attenuation Strategies

In 2010, WSDOT reviewed several past projects and found that "unconfined" bubble curtains reduced sound pressure levels by an average of 12 dB and "confined" bubble curtains achieved an average reduction of 13 dB (WSDOT 2010). However, the WSDOT study revealed, among other things, that the effectiveness of bubble curtains is highly variable – with attenuation ranging from 0 dB to 38 dB. This variability can most likely be attributed to the type of device used and whether it was properly installed.

To address the uncertainly associated with the effectiveness of bubble curtains, the Port selected a reduction of 9 dB to use for its noise modeling. This is quite conservative and the Port anticipates that bubble curtains deployed during its projects will provide greater attenuation, consistent with the reported results of WSDOT and Caltrans. It should be noted that bubble curtains have not been shown to be effective in reducing underwater noise produced by vibratory pile drivers and there are no known noise reduction strategies for vibratory hammers available at this time. Therefore, no noise attenuation / mitigation device is assumed when analyzing the effects of a vibratory pile driver.

Model Data Requirements

To run an analysis using the methods recommended by the services, the Caltrans manual, and the WSDOT manual, four key pieces of information were needed. These included:

- The dB_{Peak}, dB_{RMS}, and dB_{SEL} underwater sound metric values for a given type of piling gathered from available monitoring reports and other sources.
- The maximum number of piles per day, which was estimated through discussions with Port project managers and engineers. For both impact and vibratory pile drivers, the maximum number of piles we would expect to install is ten per day at a given facility.
- The estimated number of pile strikes needed to install the pile when using an impact hammer. Based on past work conducted by the Port, a conservative estimate of 1000 strikes per pile was used.
- The estimated ambient noise level. Grette and Associates measured a broadband ambient noise value of 130 dB_{RMS} while monitoring the vibratory installation of timber piling as part of a pile installation project at Terminal 18 in the winter of 2010. A later more advanced ambient noise study conducted by WSDOT in Spring 2011, published shortly after the Port completed its noise analysis, recorded a similar broadband ambient noise value of 128 dB_{RMS}.
- The threshold to which analysis was being performed. Each threshold presented in Table 1 and Table 2 above was analyzed.

Port of Seattle Sound Evaluation (POSSE) Excel-based tool

The Port developed the Port of Seattle Sound Evaluation (POSSE) tool to build on and improve the Stadler and Woodburry (2009) model. Benefits of the POSSE tool include:

- reduces the repetition needed to calculate the distances to multiple thresholds;
- eases data input requirements;
- allows source sound levels to be input and the ranges at which the measurements were taken;
- automatically calculates the distance to each threshold using the Spherical, Practical, and Cylindrical spreading models and presents output on the same page; and,
- allows the user to change various parameters of the model such as thresholds if new science becomes available, the "F" attenuation value, nominal standard measurement range, and ambient noise level. Presents output specific to both impact and vibratory thresholds.

The POSSE impact worksheet presents thresholds based on the stationary fish model adapted from Stadler and Woodburry (2009) as well as marine mammal thresholds based on NOAA guidance. The vibratory output worksheet is limited to the marine mammal threshold since continuous noise thresholds have not been established for fish. While researching the assessment of underwater noise, a few common potential analysis pitfalls were identified including: erroneous range calculations when the source level was below the ambient noise or a threshold value; calculation of cumulative SEL at 10 meters when the range of the piling measurement was not 10 meters; and confusion over how to apply ambient noise and noise attenuation devices to the analysis.

The first issue identified was that the Stadler and Woodbury (2009) worksheet would calculate a erroneous range when the received sound pressure level at ten meters was less than a given threshold or ambient noise level. To illustrate this problem, consider the following scenario. A piling emits a SPL of 140 dB at ten meters. The threshold of interest is 130 dB. In this situation transmission loss (TL) defined in Equation 2 would be equal to 140 dB minus 130 dB, or 10 dB. Ten decibels makes sense because we have a positive sound level emitted from the piling during pile driving operations. Now consider the following alternative scenario that illustrates the problem. A piling emits a SPL of 124 dB at ten meters and the threshold we are interested in is 190 dB. The threshold has a greater decibel value than our source and therefore is not exceeded. TL would be -66 dB in this scenario and the Stadler and Woodburry (2009) tool would calculate a range. The POSSE tool that the Port developed catches these situations and marks

the cell value as "Src ≤ Thres" to indicate that the threshold is greater than or equal to the sound source level. Similarly, if a threshold is less than the ambient noise value, the field is marked as "Ambient" to indicate that the appropriate project impact area is the distance required to attenuate to the ambient noise level.

The second issue the POSSE tool addresses is the calculation of cumulative SEL at ten meters. A near-field measurement distance of ten meters appears to be the standard used for both acoustic thresholds and acoustic data measurements. The Stadler and Woodburry spreadsheet accommodates any measurement distance as input but only calculates the cumulative SEL at that range. The POSSE tool uses each spreading model to calculate acoustic metrics, including cumulative SEL, at ten meters. This ensures that the acoustic metrics are comparable regardless of the measurement range. While this approach adds some complexity to the calculations that POSSE performs in the background, the values are identical to the Stadler and Woodburry spreadsheet at ten meters assuming a ten-meter acoustic data measurement distance.

The last major issue that POSSE addresses is the application of ambient noise levels and noise mitigation devices to the spreading model. The Stadler and Woodburry (2009) tool requires the user to manually subtract the expected noise attenuation and/or ambient noise level from the source acoustic metrics. The POSSE tool simplifies this process and makes it less prone to error by providing additional input fields that control the ambient noise level and expected noise attenuation from an acoustic mitigation device. The addition of these fields should greatly simplify the use of the PSLM for project evaluation for Port staff and others who wish to use it.

If errors are identified in the POSSE tool please report them to Jon Sloan, Port of Seattle - Seaport Environmental. This tool was developed as in in-house aid for Port of Seattle staff performing noise analysis and the default values provided in the spreadsheet may not be appropriate for all environmental settings or otherwise accurate. Please independently verify your data and the model prior to relying on it for your analysis. The Port of Seattle assumes no responsibility for interpretation of the results of these models by non-Port users.

Mapping the Results

The POSSE tool was used to generate the distance to each threshold for each type of piling. The Port mapped these distances using an advanced GIS system and process.

Within the GIS, the worst case pile driving location for each facility was selected, meaning that there is no other location at the facility that is more exposed to the free spreading of underwater noises. From this pile-driving point, a GIS process constructed the area potentially exposed to underwater sounds, considering the shape of the shoreline and based on a process similar to traditional "line-of-sight" analysis. Each threshold area was constructed by buffering the pile driving point location by the calculated distance and limiting the area displayed by the area "visible" from the pile driving location. The result is an analytical representation of both the distance and extent of underwater noise related to pile driving at the most exposed location at each Port facility. The model does not account for underwater obstructions, bathymetry, or complex refraction or reflection characteristics. It is consistent with, and potentially more accurate than, recommendations to manually interpret the area, treating the shoreline as an obstruction.

Noise Modeling Results

The results of the Port's modeling efforts are presented in the tables at the end of the report. The ambient noise value used for analysis was 130 dB_{RMS} collected using a broadband analysis bandwidth. For impact pile driving the distances to the stationary fish thresholds (Peak injury, cumulative SEL, and behavior)

were calculated as well as the distances to marbled murrelet injury and disturbance, cetacean injury and disturbance, and pinniped injury and disturbance. For vibratory pile driving, the results include the distance to ambient noise, cetacean injury and disturbance, and pinniped injury and disturbance. No thresholds have been established for fish or marbled murrelets when using a vibratory hammer.

Conclusion

Both impact and vibratory pile driving create underwater noise that may be harmful to threatened and endangered fish and wildlife species if it exceeds certain threshold levels. The Port of Seattle routinely undertakes pile driving activities in support of its maritime industrial facilities, cruise terminals, marinas and commercial development. As a consequence of regulatory compliance, and to further its environmental stewardship, the Port has completed a rigorous analysis of underwater noise produced by its pile driving activities in order to gain a better understanding of the potential effects it may have.

This report includes discussion of basic hydroacoustic principles as well as model output for different types of piles, pile sizes and hammer types. Also included are facility maps that illustrate the distance to injury and disturbance thresholds for cetaceans, pinnipeds, fish, and marbled murrelets. The Port will use the modeled data and associated maps to inform project design as well as to develop effective mitigation and monitoring programs.

Impact Pile Driver

- **All values assume the use of a bubble curtain that achieves a -9 dB reduction. (ICT Jones & Stokes and Illingworth & Rodkin, Inc. 2009; WSDOT 2010)**

- **Ambient noise: 130 dB_{RMS} (Grette and Associates, LLC. 2010)**

Title	dB_{Peak}	dB_{RMS}	dB_{SEL}	Ambient Noise (dB_{RMS})	Dist to Ambient (m)	Dist to Salmonid Peak Injury (m)	Dist to Salmonid Cum. SEL Injury - mass < 2g (m)	Dist to Salmonid Cum. SEL Injury - mass ≥ 2g (m)	Dist to Salmonid Behavior (m)	Dist to Murrelet Injury (m)	Dist to Murrelet Disturbance (m)	Dist to Cetacean Injury (m)	Dist to Pinniped Injury (m)	Dist to Marine Mammal Disturbance (m)	SPL Citacian
24" Steel Sheet Pile	205	190	180	130	25119	251	251	1166	1166	117	1166	12	-	251	Illingworth and Rodkin, Inc. 2007
24" Concrete	194	181	167	130	6310	-	34	34	293	22	293	-	-	63	Laughlin 2007
36" Concrete	192	176	174	130	2929	-	100	100	136	16	136	-	-	29	WSDOT 2010
10" Steel H-Pile	190	175	155	130	2512	-	5	5	117	12	117	-	-	25	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile - Thin	190	175	160	130	2512	-	12	12	117	12	116	-	-	25	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile - Thick	195	183	170	130	8577	-	54	54	398	25	398	-	-	86	Illingworth and Rodkin, Inc. 2007
15" Steel H-Pile	195	180	170	130	5412	-	54	54	251	25	251	-	-	54	Illingworth and Rodkin, Inc. 2007
12" Steel - California	192	177	-	130	3415	-	34	34	158	16	158	-	-	34	Illingworth and Rodkin, Inc. 2007
12" Steel - Washington	208	191	175	130	29286	-	117	117	1359	185	1359	14	-	293	Laughlin 2006
14" Steel	200	184	174	130	10000	-	100	100	464	54	464	-	-	100	Illingworth and Rodkin, Inc. 2007
16" Steel	200	187	174	130	15849	-	100	100	736	54	736	-	-	158	Laughlin 2004
18" Steel Pipe	192	173	-	130	1848	-	18	18	86	16	86	-	-	18	Laughlin 2010d
20" Steel	208	187	176	130	15849	-	136	136	736	185	736	-	-	158	Illingworth and Rodkin, Inc. 2007
24" Steel	212	189	181	130	21544	-	293	293	1000	341	1000	-	-	215	Laughlin 2005a
30" Steel	212	195	186	130	54117	-	631	631	2512	341	2512	25	-	541	Laughlin 2005b
36" Steel	214	201	186	130	135936	-	631	631	6310	341	6310	63	14	1359	Laughlin 2007
12-14" Wood / Timber	180	170	160	130	1166	-	12	12	54	-	54	-	-	12	Illingworth and Rodkin, Inc. 2007

Vibratory Pile Driver

- **Ambient noise: 130 dB_{RMS} (Grette and Associates, LLC. 2010)**
- **When data Vibratory hydroacoustic data was not available a 17 dB reduction from impact levels was applied (WSDOT 2010; Nedwell and Edwards 2002).**

Title	dB_{Peak}	dB_{RMS}	dB_{SEL}	Ambient Noise (dB_{RMS})	Dist to Ambient (m)	Dist to Marine Mammal Disturbance (m)	Dist to Cetacean Injury (m)	Dist to Pinniped Injury (m)	Modelled SPLs? (dB_{impact} - 17 dB)	SPL Citacian
24" Steel Sheet Pile - Typical	175	160	160	130	316	316	12	-	False	Illingworth and Rodkin, Inc. 2007
24" Steel Sheet Pile - Loudest	182	165	165	130	2154	2154	-	-	False	Illingworth and Rodkin, Inc. 2007
24" Concrete	177	164	150	130	1848	1848	-	-	True	Laughlin 2007
36" Concrete	175	159	157	130	858	858	-	-	True	WSDOT 2010
10" Steel H-Pile	161	147	-	130	136	136	-	-	False	Illingworth and Rodkin, Inc. 2007
12" Steel H-Pile	165	150	150	130	215	215	-	-	False	Illingworth and Rodkin, Inc. 2007
12" Steel	171	155	155	130	464	464	-	-	False	Illingworth and Rodkin, Inc. 2007
14" Steel	183	167	157	130	2929	2929	-	-	True	Illingworth and Rodkin, Inc. 2007
16" Steel	183	170	157	130	4642	4642	14	-	True	Laughlin 2004
18" Steel	175	156	-	130	541	541	-	-	True	Laughlin 2010
20" Steel	191	170	159	130	4642	4642	-	-	True	Illingworth and Rodkin, Inc. 2007
24" Steel	157	151	144	130	251	251	-	-	False	Illingworth and Rodkin, Inc. 2007
30" Steel - Keystone	196	171	-	130	5412	5412	-	-	False	Laughlin 2010a
30" Steel - Vashon	187	164	-	130	1848	1848	-	-	False	Laughlin 2010c
36" Steel Pipe (Loudest)	185	175	175	130	10000	10000	25	-	False	Illingworth and Rodkin, Inc. 2007
36" Steel Pipe (Typical)	180	170	170	130	4642	4642	63	-	False	Illingworth and Rodkin, Inc. 2007
12" Wood / Timber	163	153	143	130	341	341	-	-	True	Illingworth and Rodkin, Inc. 2007
18" Wood / Timber	-	155	-	130	464	464	-	-	False	Grette and Associates, LLC. 2010

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Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment A. Bankline Decision Flowchart

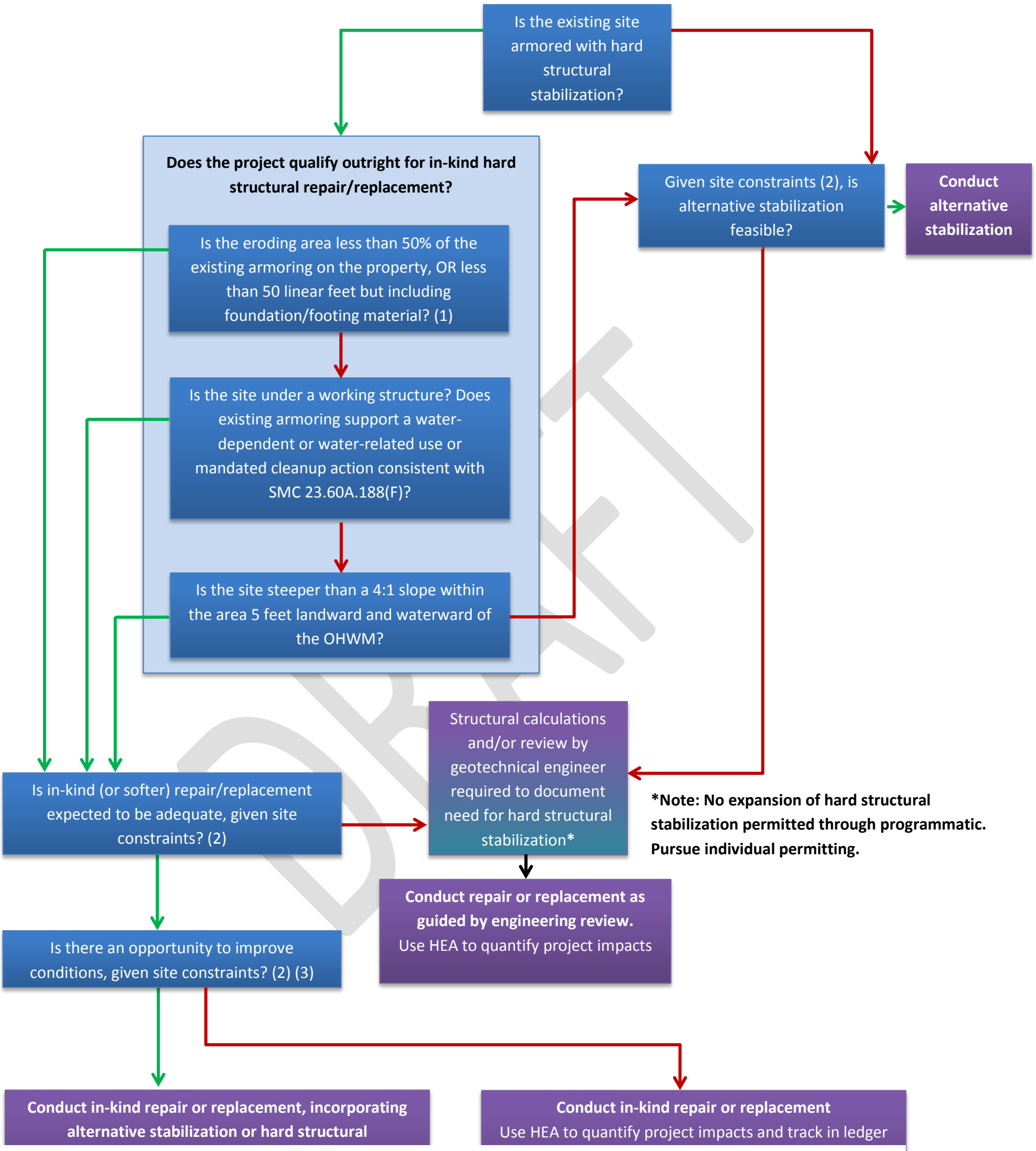
Port of Seattle Bankline Repair and Enhancement Program

Bankline Decision Flowchart

December 2018

Where bankline repair need is identified, use the following decision tree to determine feasible options.

Green arrow = YES
Red arrow = NO
Black arrow = required next step



***Note: No expansion of hard structural stabilization permitted through programmatic. Pursue individual permitting.**

(1) Repair threshold based on consideration of Port property circumstances and shoreline regulations in similar jurisdictions. Note that for use of NWP 13, project should also be less than 500 (but potentially up to 1000) linear feet of shoreline and less than one CY fill per linear foot of shoreline.

(2) Site constraints may include adjacent uses, public access requirements, existing topography and bathymetry, degree of wind and wave exposure, and existing and anticipated erosional forces.

(3) Stabilization treatments in order of declining preference:

Alternatives to stabilization / passive options:

- Set back upland use
- Beach nourishment
- Upland drainage control

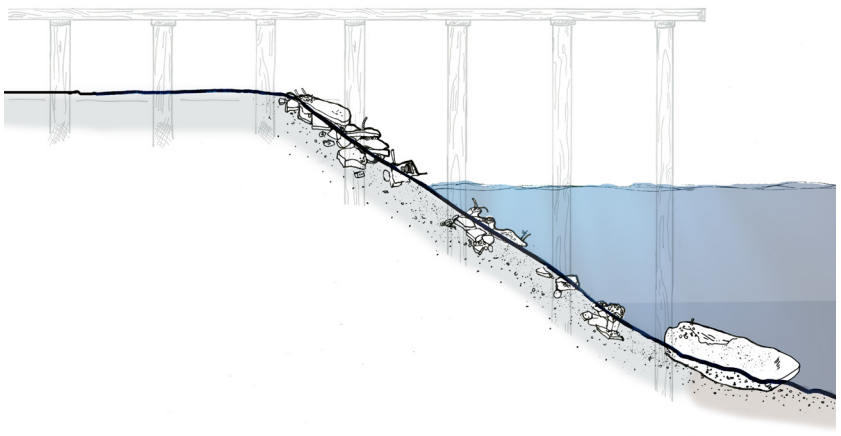
Alternative stabilization (see Alternative Stabilization Typicals "B")

Hard structural stabilization (see Hard Structural Stabilization Typicals "A")

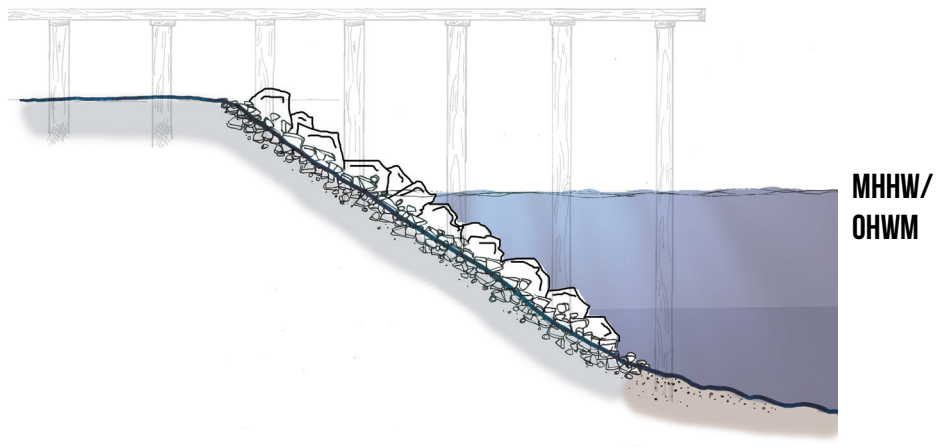
Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment B. Design Typicals

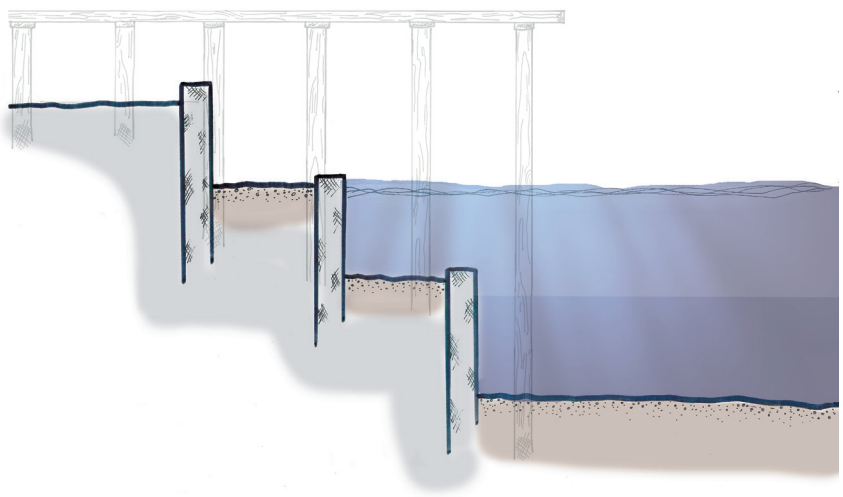
A1. RUBBLE STREWN SLOPE



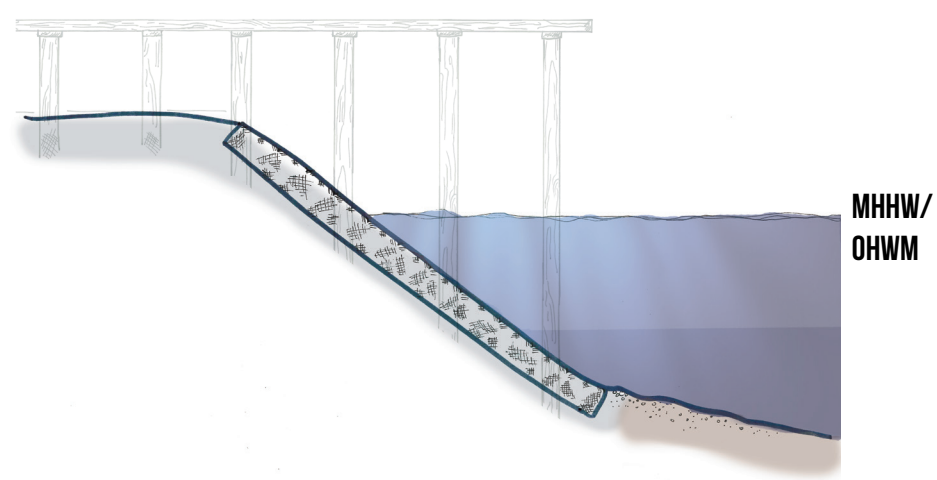
A2. CONVENTIONAL ARMORED SLOPE



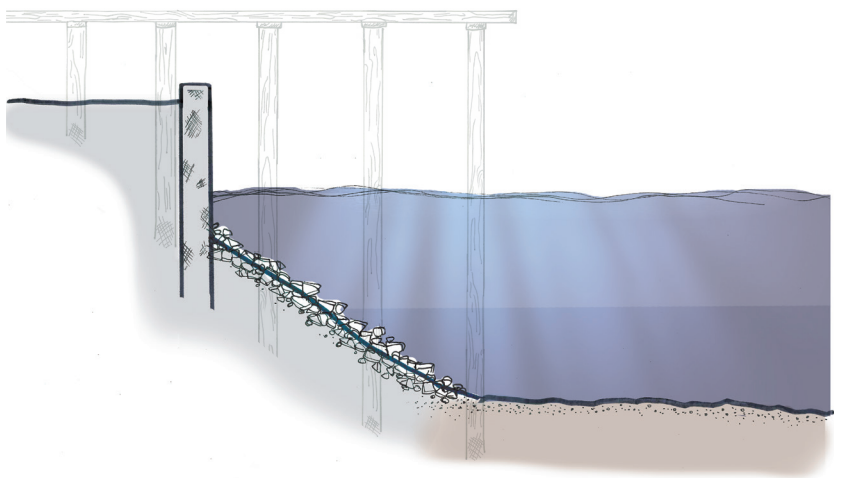
A3. STEP WALL BULKHEAD

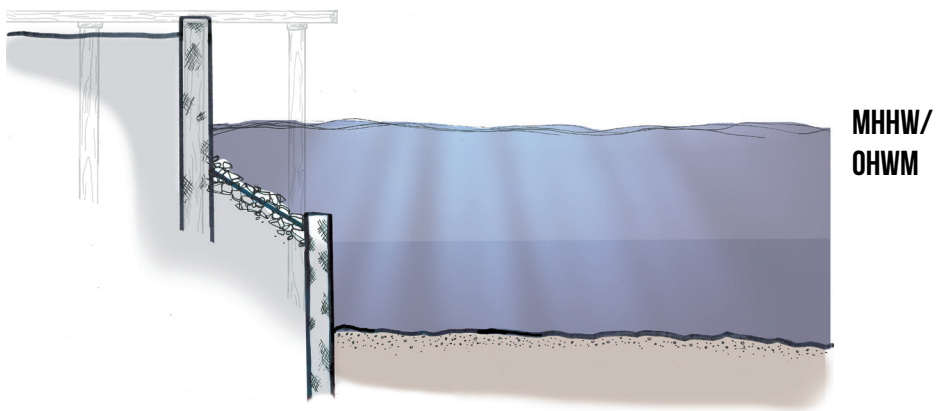


A4. SLOPED BULKHEAD

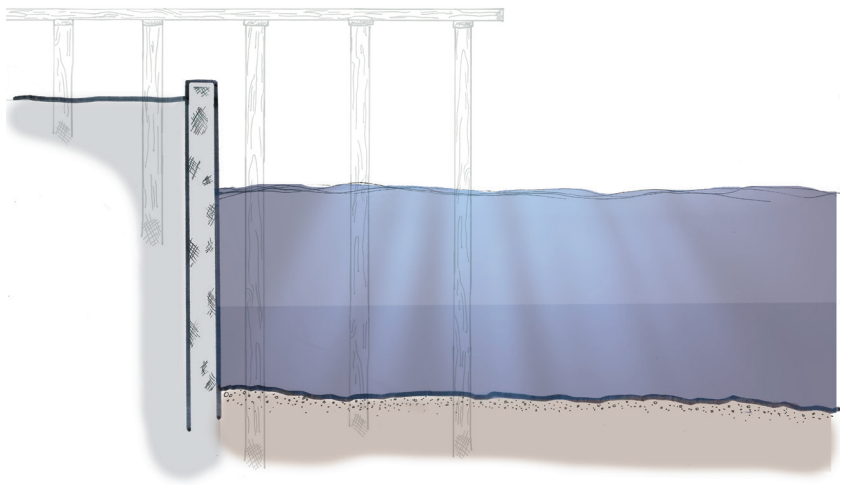


A5 BULKHEAD AND CONVENTIONAL ARMORED SLOPE OPTIONS





A6. VERTICAL BULKHEAD

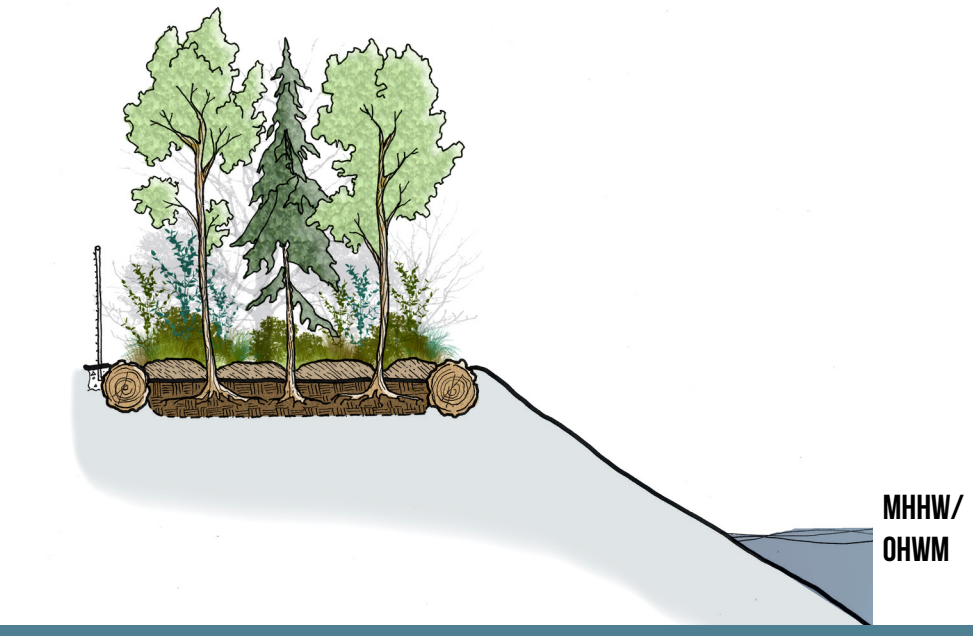


-Pier optional in A1-A6

HARD STRUCTURAL STABILIZATION TYPICALS 'A'

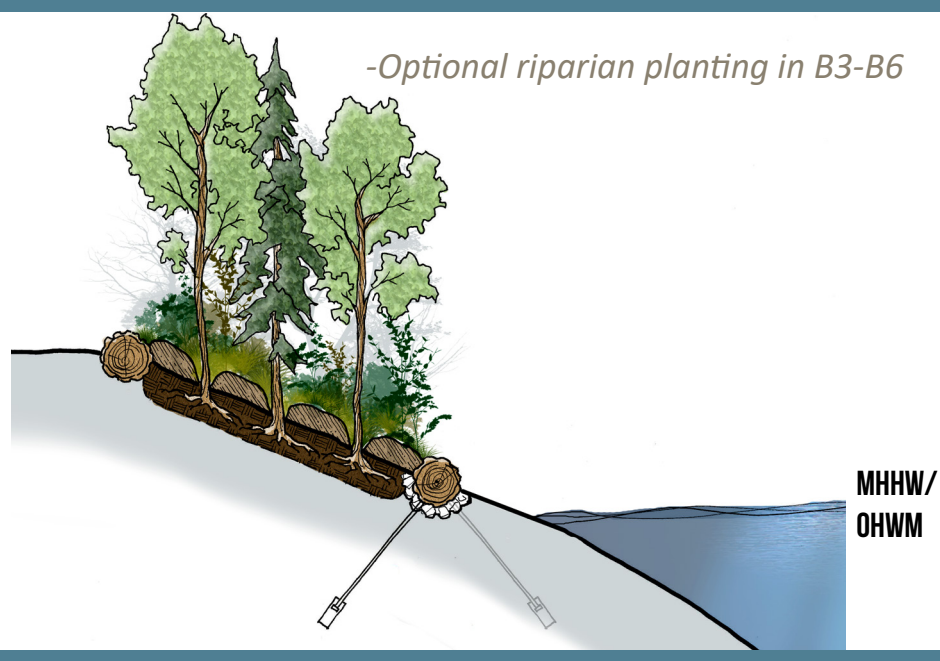
The Watershed Company

B1. TOP OF SLOPE RIPARIAN BUFFER

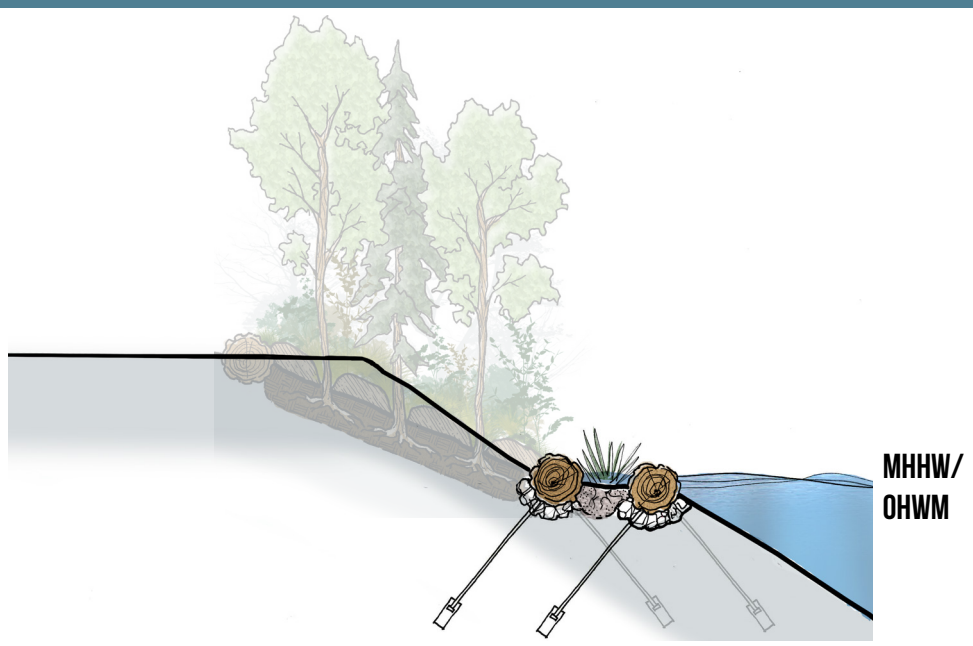


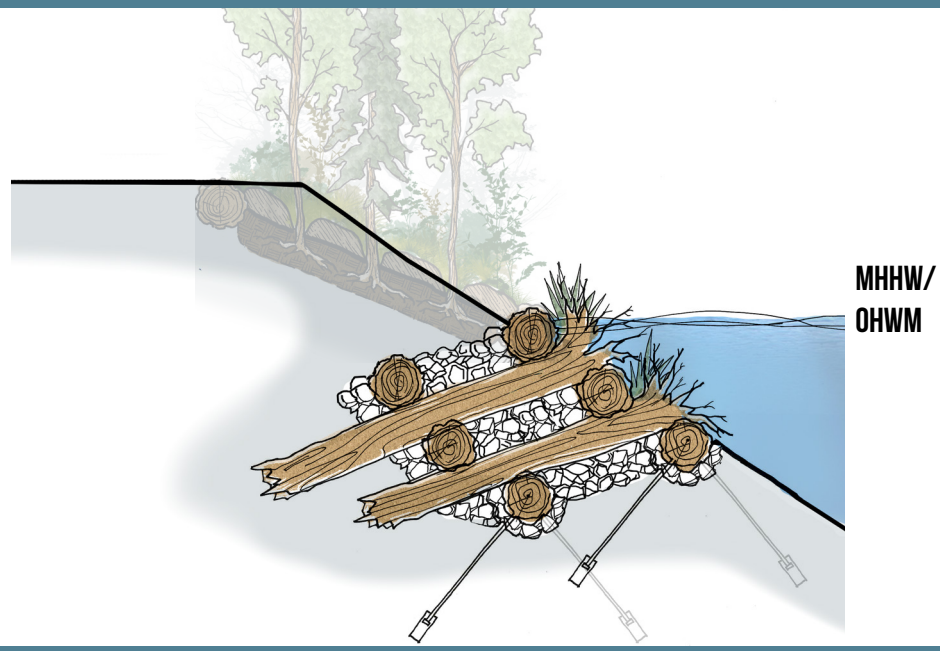
B2. ON-SLOPE RIPARIAN BUFFER

-Optional riparian planting in B3-B6

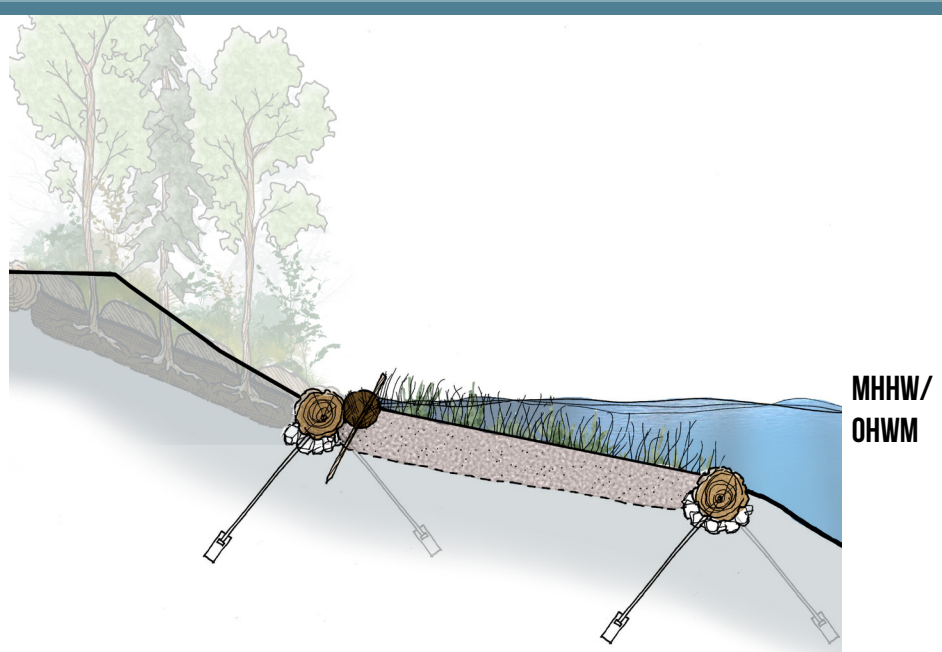


B3. TRANSITION ANCHOR SYSTEM OPTIONS: EMERGENT EDGE AND CRIBWALL

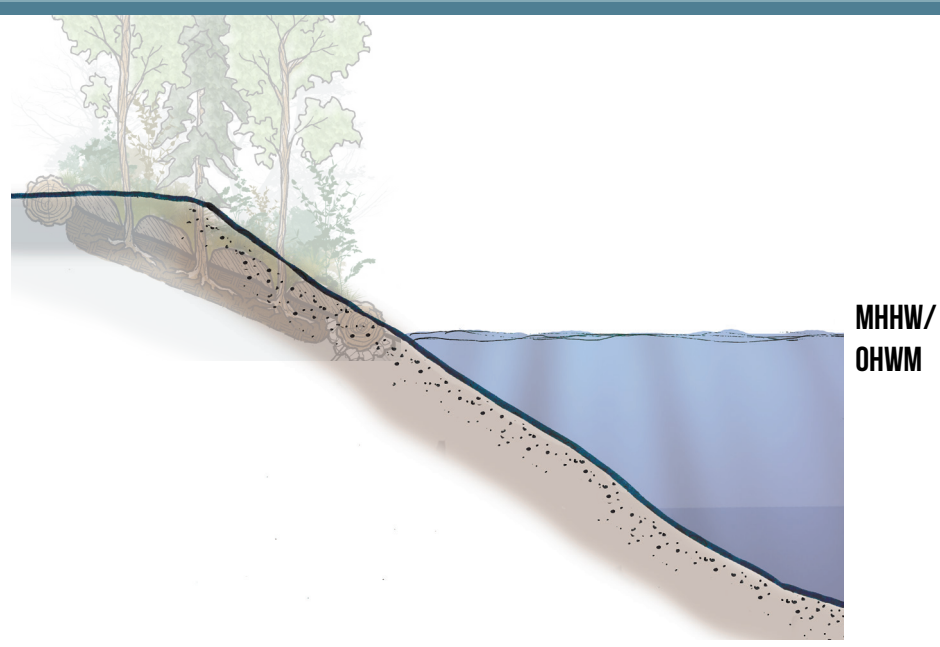




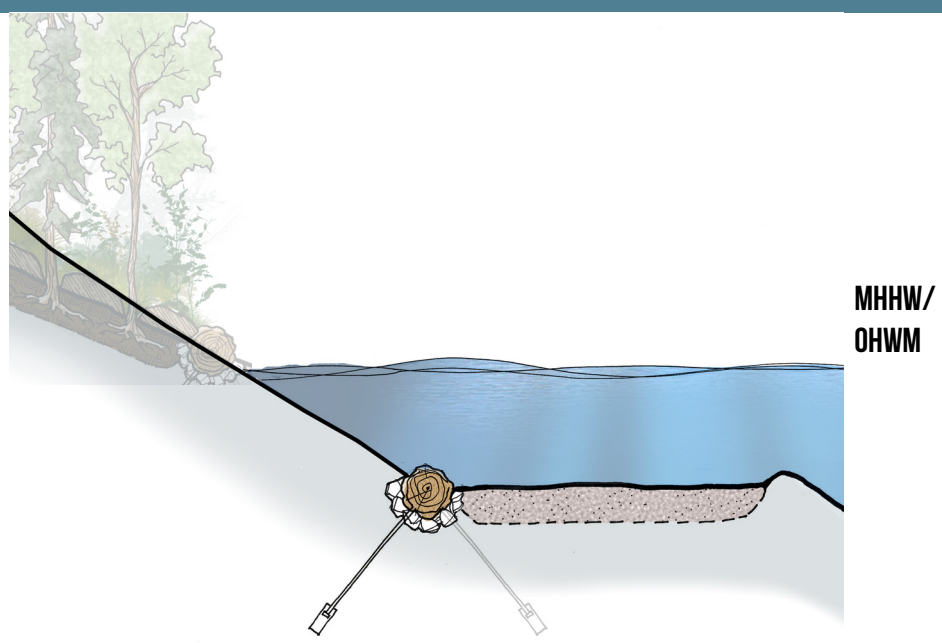
B4. EMERGENT MARSH BED



B5. NATURAL BEACH



B6. INTERTIDAL OR SUBTIDAL BENCH



PLANT CANDIDATE LIST (B1 - B6)

Upland Plants (Above 15.5 ft):
Western redcedar, Shore pine, Paper birch, Bigleaf maple, Sitka spruce, Redtwig dogwood, Nootka rose, Oregon grape, Evergreen huckleberry, Red flowering currant, Vine maple, Salmonberry, Highbush cranberry, Beaked hazelnut, Baldhip rose, Woods rose, Coastal strawberry, Salal, Puget Sound beach grass

Riparian Plants (13.5 - 15.5 ft):
Redtwig dogwood, Hooker's willow, Scouler's willow, Puget Sound beach grass

High Marsh Plants (12.5 - 13.9 ft):
Fleshy jaumea, Saltmarsh bulrush, Tufted hairgrass, Pacific silverweed, Puget Sound gumweed

Low Marsh Plants (11.4 - 12.5 ft):
Lyngby's sedge, American threesquare, Saltgrass

ALTERNATIVE STABILIZATION TYPICALS 'B'

THE WATERSHED COMPANY

A1. RUBBLE STREWN SLOPE

Existing:

Some shoreline areas on Port-owned properties reflect a history of ad-hoc shoreline stabilization using a combination of derelict materials, including broken concrete, tires, and other debris. These shorelines typically occur on slopes flatter than 2:1. They may reflect different periods of shoreline stabilization efforts, in which different techniques or materials were employed.

Proposed:

Derelict materials will be removed when rubble-strewn banks are modified. When modified, alternative shoreline stabilization options will be considered and implemented as feasible on rubble-strewn banks (See Typicals B).

A2. CONVENTIONAL ARMORED SLOPE

Existing:

Conventional armored slopes are the most common type of shoreline stabilization on Port properties, occurring over a quarter of Port-owned shorelines. Historically, conventional armored slopes were used on slopes approximately 1:1 or 5:1 (horizontal: vertical). Existing conventional armored slopes at port facilities include fractured/angular stone, crushed rock materials, concrete fragments, and a variety of other materials used to stabilize and protect previously filled shorelines.

Proposed:

Proposed repair and maintenance activities may include repositioning existing inert materials to their original design, reinforcing areas that have experienced slumping, scour, or localized damage, or replacing the conventional armored slope with riprap sized according to the anticipated forces involved. The slope and size of the armoring is determined based on geotechnical and civil/coastal engineering requirements. Replacement would include a gravel filter layer, riprap armor layer, and toe-of-slope "keyway." Most replacement riprap material will range from 18-24 inches in diameter. Repaired armored slopes may incorporate a variety of stable rock sizes, including large boulders, to increase habitat niches and interstitial cavities. The Port has employed this approach at Pier 2 to provide a more complex substrate.

Of the hard stabilization treatments described in this section, riprap armored slopes would be considered one of the least disruptive hard shoreline stabilization method because they include interstitial spaces and cavities that provide modest refuge and habitat niche diversity for marine and estuarine fish and wildlife, algae, and aquatic vegetation, and their sloped, rough surface helps to absorb and dissipate wave energy.

A3. STEP WALL BULKHEAD

Existing:

Step wall bulkheads are relatively rare on Port properties, occupying just 200 feet of shoreline length at two locations. Step wall bulkheads are used where slopes are steep, but not vertical. They incorporate both vertical and near-horizontal elements. Existing vertical elements of step wall bulkheads on Port properties include sheet pile and gabion baskets. The horizontal elements consist of crushed rock.

Proposed:

Proposed repair and maintenance of step wall bulkheads may include replenishing material along the horizontal elements, reinforcing areas of localized damage, or replacing the vertical and horizontal elements. Vertical elements of replacement step wall bulkheads may include concrete, sheet pile, or timber pile bulkheads, but will not include gabion baskets. In a repaired step wall bulkhead, the horizontal element can be designed to mimic natural low-gradient shoreline habitat, similar to Alternative Treatment #6 - Intertidal Bench.

Similar to conventional armored slopes, step wall bulkheads help dissipate and absorb wave energy. Step walls may be considered as a lower-impact alternative when replacing existing vertical bulkheads.

A4. SLOPED BULKHEAD AND BOAT RAMPS

Existing:

A sloped bulkhead is typically constructed of concrete or other rigid material. This treatment is used where scour risk or other constraints make conventional armor infeasible. For the purpose of the classification of existing shoreline conditions, boat ramps are considered equivalent to sloped bulkheads.

(A4. SLOPED BULKHEAD AND BOAT RAMPS CONTINUED)

Proposed:

Proposed repair and maintenance of a sloped bulkhead may consist of localized repair or replacement. Pre-cast concrete panels will be used instead of cast-in-place concrete where feasible. Cast-in-place concrete mattresses are not included as a proposed design alternative under this programmatic permit.

The slope of this treatment helps dissipate wave energy, but it tends to lack interstices used by marine and estuarine fish and wildlife, algae, and aquatic vegetation. Where a new sloped bulkhead is proposed, there may be opportunities to incorporate features such as articulated or grid mats, which support interstitial biota.

A5. BULKHEAD AND CONVENTIONAL ARMORED SLOPE

Existing:

This bankline type incorporates a vertical or near-vertical bulkhead element at the shoreline extending into the intertidal or subtidal zone. The bank transitions to a conventional armored slope waterward from the toe of the bulkhead in the intertidal or subtidal zone (see A2). In some locations, a toe wall is present at the base of the conventional armored slope. This tow wall configuration is typically used to maintain adequate depth adjacent to an overwater structure for moorage of deep-draft vessels, such as a Terminal 5 and Terminal 18.

This design combines a conventional armored slope (see A2) in the intertidal zone with a vertical bulkhead (see A6) in the subtidal area to increase toe-of-slope stability.

Proposed:

This design has the advantage of maintaining a sloped area with interstitial spaces in inter-tidal and shallow sub-tidal nearshore area, while allowing vessel moorage and navigational access in adjacent deep sub-tidal aquatic areas. In general, this design will be repaired or replaced in-kind where it already occurs.

This treatment tends to reflect wave energy and does not provide habitat benefits. However, in some instances, complex, textured surfaces can be incorporated to improve conditions for marine and estuarine algae, aquatic plants, and invertebrates. Such textured surfaces will be incorporated in vertical bulkhead elements, where feasible. Additionally, repaired or augmented armored slopes may incorporate a variety of stable rock sizes to increase habitat niches and interstitial cavities.

A6. VERTICAL BULKHEAD

Existing:

This treatment consists of a vertical structure extending at or above MHHW to subtidal elevations. Existing vertical bulkheads on Port properties are constructed of sheet pile, timber pile, and concrete. Vertical bulkheads are typically backed by drain rock and a drainage system and can incorporate earth anchors or other tie-backs to improve stability. Vertical bulkheads typically occur where there is an immediate need to access subtidal waters from shore, such as marine cargo and transportation facilities.

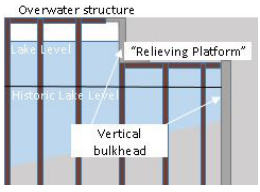
The South Wall at Fisherman's Terminal in the Lake Washington Ship Canal provides an example of one unusual vertical bulkhead configuration. At that site, a vertical bulkhead was built prior to the construction and operation of the Hiram Chittenden Locks to an elevation that is below the current low lake level. An additional vertical non-engineered bulkhead (known as a gravity wall) was built atop the waterward extent of what was historically an overwater structure, but is now submerged by the lake (see figure below).

Proposed:

Vertical bulkheads may be replaced with steel sheet pile, concrete, or soldier pile systems. Of the hard stabilization treatments described in this section, vertical bulkheads would be considered the most environmentally disruptive form of hard armoring because they potentially eliminate the intertidal zone and reflect wave energy, causing scour at the toe. Similar to A.5., in some instances, complex, textured surfaces can be incorporated into the bulkhead to improve conditions for marine and estuarine algae, aquatic plants, and invertebrates. Such textured surfaces will be incorporated in vertical bulkhead elements, where feasible.

GENERAL NOTES

1. *Overwater structures may be present in conjunction with any of the shoreline treatments described above. The presence of an overwater structure may affect bankline stabilization needs and associated designs appropriate for a given site.*
2. *Derelict piles may be present at or immediately offshore of the existing bankline. Removal of these derelict piles will be evaluated where bankline work is proposed.*



B1. TOP OF SLOPE RIPARIAN BUFFER

Existing Conditions:

The Port has employed the Top of Slope Riparian Buffer treatment at a number of sites where the slope cannot be modified due to site constraints, but where there is sufficient space at the top of slope to allow for native plant establishment. Vegetation is located at the top of slope (i.e. not extending below the top of bank) and the width of the riparian buffer varies depending on constraints from upland land uses. Examples of existing top of slope riparian buffers that have been restored by the Port include Terminal 104, Terminal 107, and Centennial Park. In some locations, patches of non-native, invasive vegetation occur between shoreline stabilization measures and upland uses. The Top of Slope Riparian Buffer treatment may be considered as a treatment for these areas.

Proposed Conditions:

The Top of Slope Riparian Buffer treatment will be employed at sites with steep narrow slopes that cannot be modified, but where there is at least a 10-foot-wide space at the top of bank for vegetation enhancement. This treatment typically consists of excavating a trench at least five meters in length and one meter deep, lining it with coir fabric, and filling with clean imported soil. An additional foot of mulch or arborist chips is added on top of the fill material. Dense riparian plantings, consisting primarily of trees and shrubs, are planted and a drip irrigation system installed. Large woody debris (LWD) will border both the landward and waterward margin of the riparian buffer. No substantial modifications are made to the existing slope as part of this treatment, but it may be combined with other alternative or hard stabilization treatments.

This treatment is appropriate for a variety of shoreline conditions. Once implemented, environmental benefits include water quality, shade, stormwater infiltration, and riparian habitat, and export of organic material and terrestrial insects to adjacent aquatic areas.

B2. ON-SLOPE RIPARIAN BUFFER

Existing Conditions:

Existing on-slope riparian buffer conditions primarily occur where the Port has conducted past riparian restoration efforts. Examples of existing on-slope riparian buffers include Terminal 108 Public Access, Terminal 105 Park, and Terminal 107. Kellogg Island is one of the only areas on Port properties with a naturally occurring native on-slope riparian buffer.

Proposed Conditions:

The On-slope Riparian Buffer can be employed at sites where minimal slope excavation and regrading can occur, but where the site is otherwise constrained by site characteristics and property lines. This treatment extends from top of slope down to MHHW. Depending on the existing slope, the treatment may require regrading to a maximum slope of 2:1. The slope is lined with a coir fabric "pillow" – coir fabric layered with 1 to 2 feet of clean imported soil and covered with a second layer of coir fabric. Dense riparian plantings consisting primarily of trees and shrubs are then planted directly into the coir fabric and surrounded by 1 foot of arborist chips. A drip irrigation system is installed. Due to the potential interaction between the plants and tidal waters at the waterward margin of the riparian buffer, this treatment includes more transitional species at lower elevations compared to B.1. A toe log is installed at the highest anticipated water level and anchored into a sub-grade rock bolster.

Once restored using this treatment, environmental benefits include water quality, shade, stormwater infiltration, and riparian habitat, and export of organic material and terrestrial insects to adjacent aquatic areas. Due to the typically lower and gradual elevations, this condition can provide more direct ecological benefit to estuarine habitat compared to B.1.

B3. TRANSITION ANCHOR SYSTEM

Existing Conditions:

The Transition Anchor System is used as a transition from in-water treatments to the waterward edge of the riparian buffer. The Port has successfully employed transition anchor systems at restoration areas at Terminal 108 public access and Centennial Park. In the simplest system, a transition log is located at the highest anticipated water level and anchored into a rock bolster. It may be expanded to include a sacrificial log, located immediately below the transition log, which is similarly anchored into a rock bolster. In this case, the area between the two parallel logs is lined with coir fabric, covered in habitat substrate, and planted with transitional species. The purpose of the waterward row of anchored logs is to prevent erosion at the base of the riparian slope during the plant establishment period. Once established, the transitional plants limit erosion.

Proposed Conditions:

In most cases, the Transition Anchor Systems will be implemented as a transition between different types of alternative stabilization measures, or between alternative and hard structural stabilization. In some cases, this treatment may simply include placement of large woody debris along existing banklines to support additional habitat functions.

In some cases a Transition Anchor System in the form of a log crib wall may be used as a replacement alternative for a conventional armored slope. Log crib walls are constructed using interconnected logs with attached root wads. A combination of parallel and transverse logs are stacked and anchored together. The structure is then backfilled with clean material, effectively covering all but the outermost portion of the crib wall. At elevations above +8 feet MLLW, the spaces between the logs can be inter-planted with

(B3. TRANSITION ANCHOR SYSTEM CONTINUED)

transitional or emergent vegetation.
Ecological benefits of this treatment include shade, sediment recruitment, erosion control, invertebrate habitat, slope stabilization, and wildlife habitat.

B4. EMERGENT MARSH BED

Existing Conditions:
Existing emergent marsh conditions are present on Port properties at Terminal 107, Terminal 105 Park, and Turning Basin Number 3. With the exception of Kellogg Island at Terminal 107, these marsh conditions represent past restoration efforts by the Port. Under separate permits, the Port plans to restore emergent marsh at Terminal 117 and Terminal 25 South.

Proposed Conditions:
In the context of this permit, the Emergent Marsh Bed treatment may be employed to address issues such as erosion or plant mortality in existing emergent marsh areas. It may also be used in small areas to in place of existing Rubble-Strewn Banks where debris and armoring remnants prevent or block the growth of intertidal emergent plants and limit use by intertidal organisms. This treatment requires gradual slopes, and may be located immediately below a Transition Anchor System (see B3), extending to the lower limits of the upper intertidal zone (+6 feet MLLW). The treatment includes emergent plants bedded in fine grain sediment with underlying coir fabric. It is bounded by an anchored log on a subgrade rock bolster at the waterward edge. This treatment may be combined with B1, B2, or B3.
The Emergent Marsh Bed provides critical habitat for a wide range of fish and wildlife species. It also provides water quality improvement, sediment recruitment, erosion control, flow attenuation, and organic export.

B5. NATURAL BEACH

Existing Conditions:
Natural beaches occur on gradual slopes where space allows and where wave energy is low enough that material is stable over time. Natural beaches may incorporate features such as large woody debris or boulders. Terminal 5 and Jack Block Park provide the best examples of existing natural beach conditions. These conditions were restored by the Port following a large sediment cap.

Proposed Conditions:
In the context of this permit, the Natural Beach treatment may be used to address erosion issues at existing beaches or to replace existing shoreline stabilization measures with natural beach conditions, where feasible, given slopes and site constraints. Repair of existing Natural Beaches may entail addition of clean sediment appropriate for the site conditions and/or placement or anchoring of large woody debris. Replacement of existing structures with a natural beach would entail grading to a uniform slope, adding substrate material ranging from sand to gravel appropriate for the zone (i.e. estuarine, marine, or freshwater), anchoring large woody debris, and strategically placing boulders to resist erosion. The Natural Beach provides fish and wildlife habitat, in-water habitat substrate, and recreational opportunities.

B6. INTERTIDAL OR SUBTIDAL BENCH

Existing Conditions:
Through past maintenance and restoration actions, the Port has established intertidal and subtidal benches in areas along the shoreline. An intertidal bench was created to enhance ecological functions along a riprap slope at Terminal 104. At the south end of Terminal 25, the Port created boulder habitat mounds to support kelp recruitment.

Proposed Conditions:
In the future, the Intertidal or Subtidal Bench treatment may occur where a horizontal break in otherwise steep slopes would provide improved productivity and fish and wildlife habitat. They can be constructed on naturally-occurring or Conventionally Armored Slopes where longshore current and wave energy are minimal. The width of the bench depends on site-specific characteristics, including slope. In this treatment, the intertidal bench is lined with biodegradable geotextile fabric and covered with fine grain sediments similar to that of a natural low-gradient riverbank. At the waterward margin of the intertidal bench, a small raised reinforced lip helps to retain sediment within the intertidal bench. Transverse logs may be partially buried and anchored within the bench to retain and recruit sediment through longshore drift processes.
Environmental benefits include benthic productivity, including fish, invertebrates, and aquatic vegetation.

GENERAL NOTES

1. *Additional subtidal and intertidal restoration opportunities may include shellfish beds, seagrass, or kelp bed restoration and establishment.*
2. *Derelict piles may be present at or immediately offshore of the existing bankline. Removal of these derelict piles will be evaluated where bankline work is proposed.*

Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment C. Conservation Measures Checklist

Port of Seattle Bankline Repair and Enhancement Program NWS-2018-780-WRD

Conservation Measures Checklist

December 2018

This checklist identifies standard conservation practices applicable to bankline repair and enhancement at the Port of Seattle-controlled properties.

The first column indicates consistency with the Seattle Biological Evaluation Conservation Measures (numbered), Port of Seattle conservation measures employed in other projects, or Corps of Engineers conservation measures.

This checklist will be submitted prior to construction for each project proposed under the Multi-Site Program. A written justification for any applicable measures marked as "does not meet" will accompany the checklist submittal.

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
General Conditions (all projects)				
Port	The contractor will comply with permit conditions.	☐	☐	☐
25	Minimize riparian crossings	☐	☐	☐
Corps SPIF	Completed repairs will not exceed the footprint of the previously armored bank. All repairs will be in-kind and in-place at the existing structure, unless repairs include only bioengineering features.	☐	☐	☐
65	Retrieve and remove debris that enters waterbody	☐	☐	☐
Port	Use tarps or other methods to prevent treated wood, sawdust, trimmings, drill shavings and other debris from contacting the bed or waters of the state.	☐	☐	☐
Temporary Erosion and Sediment Control (all projects)				
2	Onsite Temporary Erosion and Sediment Control Plan	☐	☐	☐
5	Confine construction impacts to the minimum area necessary, delineate impacts on project plans and onsite.	☐	☐	☐
6	Establish staging and site access areas along existing roadways or other disturbed areas	☐	☐	☐
7	Limit clearing and grubbing areas to minimum required, retain vegetation to maximum extent	☐	☐	☐
12, 27	Use sediment barriers to prevent erosion and sediment from entering waterbodies	☐	☐	☐
13	Keep erosion control materials onsite to respond to emergencies	☐	☐	☐
14	Use curb inlet sediment traps and geotextile filters to capture sediment before it leaves the site	☐	☐	☐

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
22	If equipment wash areas are required, locate them where washwater, sediment, and pollutants cannot enter waterbodies	☐	☐	☐
23	Do not track sediment onto paved streets or roadways	☐	☐	☐
24	Remove equipment and excess supplies, clean work storage areas, and remove temporary erosion control materials and temporary fill after construction and when soils have stabilized	☐	☐	☐
27	Place erosion and water quality control devices prior to beginning of work	☐	☐	☐
Spill Prevention and Response (all projects)				
3	Onsite Spill Prevention and Control Plan	☐	☐	☐
Port	Corrective actions will be taken in the event of any discharge of oil, fuel, or chemicals into the water (WAC 173-201A), including: • In the event of a spill, containment and cleanup efforts will begin immediately, taking precedence over normal work. Cleanup will include proper disposal of any spilled material and used cleanup material. • The cause of the spill shall be assessed and appropriate action will be taken to prevent further incidents or environmental damage.	☐	☐	☐
Port	Spills and/or conditions resulting in distressed or dying fish shall be reported immediately to DOE's Northwest Regional Spill Response Office at (425) 649-7000 (a 24-hour phone number) (WAC 173-201A). Spills of oil or hazardous materials also shall be reported immediately to the National Response Center at 1 (800) 424-8802 and the Washington Emergency Management Division at 1 (800) 258-5990 or 1 (800) OILS-911.	☐	☐	☐
Port	The contractor will report all incidents and implement corrective measures if temporary water quality standards are exceeded.	☐	☐	☐
4	Check equipment daily for leaks and complete any required repairs before using the equipment in or near the water. Maintain a spill kit onsite	☐	☐	☐
16	Fuel equipment in staging areas	☐	☐	☐
Port	All stationary, motor-powered equipment set-up, including compressors and generators, will be located on isolation pads, fitted as "drip pans", for containment of petroleum materials.	☐	☐	☐
Port	Prevent contaminants from the project, such as petroleum products, hydraulic fluid, fresh concrete, sediments, sediment-laden water, chemicals, or any other toxic or harmful materials, from entering or leaching into waters of the state.	☐	☐	☐
Projects involving excavation				☐
9	Implement BMPs to prevent erosion of excavated material			

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
10	Stockpile large wood, vegetation, and soils for establishment of staging area and site restoration	☐	☐	☐
11	Salvaged debris such as roots and stumps may be used for habitat. Disposal of debris may include chipping, shredding, or grinding for reintroduction to the site as mulch.	☐	☐	☐
	Water quality standards and procedures that limit the impact of turbidity to a defined mixing zone would be observed (WAC 173-201A).	☐	☐	☐
21	Stockpile native streambed or substrate material	☐	☐	☐
Projects planting or removing vegetation				☐
63	Take care to prevent spread of invasive plant species during their removal	☐	☐	☐
64	Plant with native vegetation	☐	☐	☐
Projects adding fill				☐
59	Use clean, washed material	☐	☐	☐
67	Use only clean material appropriate for the ecological setting	☐	☐	☐
Conservation measures for work below the OHW or MHHW				☐
1	Approved in-water work windows as established by the agencies. Presently: Duwamish River - mouth to upper turning basin Oct 1 – Feb 15 Elliott Bay- Jul 16-Feb 15 Elliott Bay- Oct 1-Feb 15 in kelp, eelgrass, or large rocks for rockfish If forage fish spawning habitat is documented in the project area, then the work window for that species applies. Surf smelt April 1-Aug 31, Pacific herring May 1-Jan 14, Pacific sand lance Mar 2-Oct 14 Any in-water work proposed to occur between October 1 and December 1 would be in accordance with an Interlocal Agreement between the Port and the Muckleshoot Tribe to prevent interruption of Tribal fishing activities. Work in the dry may occur outside of the in-water work windows	☐	☐	☐
31, 57, 58, 60	Follow proper work area isolation measures • Perform all work in the dry if possible, when tide levels allow a 2-ft vertical separation or a 6-ft horizontal separation between the work and the LDW water. • Back-blade, smooth, and cover exposed soils with anchored filter fabric prior to each cycle of tidal inundation • Pump-out and treat any water that enters the work area • Pumps shall be properly screened if there is any potential for fish presence	☐	☐	☐

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
	• Where isolation is not possible, use a sediment curtain Do not remove deployed sediment curtains until turbidity within the work area has returned to background levels			
15	Clean equipment that will work below the OHW or MHHW lines or in riparian or shoreline areas	☐	☐	☐
17	Onsite oil absorbing floating booms when equipment operates below the OHW or MHHW	☐	☐	☐
18	Use vegetable-based hydraulic fluid when equipment operates below the OHW or MHHW	☐	☐	☐
28	If mechanized equipment is used within the OHW or MHHW, only an extension arm with bucket or similar attachment shall enter the water. Conduct debris removal and work below OHW or MHHW during low water levels (fresh waters) or at low tide (marine waters)	☐	☐	☐
29	Confine use of equipment operating below OHW or MHHW to designated access corridors	☐	☐	☐
30	Develop a TDP for any dewater lasting more than 1 day	☐	☐	☐
Projects that require fish handling				☐
32	Follow proper fish capture and handling measures Use seining to herd fish out of the area where feasible	☐	☐	☐
Port	Operations will be stopped temporarily if listed species are observed as injured, sick, or dead in the project area to evaluate whether additional listed species are present and to assess whether operations may continue without further impact. NOAA Fisheries law enforcement will be notified, and species will be handled with care to ensure effective treatment or analysis of cause of death or injury.	☐	☐	☐
Projects using a construction barge or float				☐
62	Do not ground or rest construction barge on substrate or on vegetation. Operate vessels with minimal propulsion power to avoid prop scour damage to the bed and marine vegetation habitats.	☐	☐	☐
Port	Restrict vessel operation to tidal elevations adequate to prevent propeller related damage to seagrass and kelp.	☐	☐	☐
Port	Relocate construction vessels moored over seagrass between March 21 and September 21 every 4th day to minimize shading of seagrass.	☐	☐	☐
Projects repairing or replacing a bulkhead				☐
70	Move bulkhead as far landward as feasible	☐	☐	☐
71	Incorporate habitat complexity and alternative bank stabilization measures into bulkhead where feasible	☐	☐	☐

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
72	Plant bulkhead with native riparian vegetation where feasible	☐	☐	☐
73	Include rootwads and LWD with riprap if feasible	☐	☐	☐
74	Cover riprap with habitat mix to fill voids unless it will wash away rapidly	☐	☐	☐
Projects using cured-in-place concrete				☐
69	Avoid in-water contact with wet concrete or epoxy to the extent feasible.	☐	☐	☐
Port	Avoid in-water use of glue, epoxy, and other adhesive compounds	☐	☐	☐
Projects replacing sheetpile				☐
48	Do not use piling treated with creosote, pentachloraphenol, or coal tar. ACZA-treated timber piles shall only be used to replace existing treated timber piles, and only when no other material is practicable as determined by an engineering analysis.	☐	☐	☐
49	Do not use hydraulic water jets to remove or place piling	☐	☐	☐
50	Replace piling in same general location	☐	☐	☐
51	All treated wood removed will be contained on land or barge to preclude sediments and contaminated material from entering water.	☐	☐	☐
Port	Conduct repair/maintenance or pile caps, beams, rub strips, wraps, and blankets in the dry	☐	☐	☐
Port	Only use environmentally safe products for pile cleaning	☐	☐	☐
Port	Install cathodic protection manually using divers	☐	☐	☐
Port	Use aluminum anodes for cathodic protection where needed	☐	☐	☐
Port	Use a vibratory hammer whenever possible to replace sheetpile. An impact hammer may be used to proof piles, if needed.	☐	☐	☐
Port	Deploy noise attenuation measures to during all impact pile driving.	☐	☐	☐
Port	Conduct marine mammal monitoring for all pile installation in Elliott Bay and Puget Sound.	☐	☐	☐
Projects removing piles				
EPA	Pile removal will comply with EPA's "Best Management Practices for Pile Removal and Disposal" (2007)	☐	☐	☐
Port	If piles break during removal and cannot be mechanically extracted, cut them off at the mudline and cap with 6-inches of clean sand.	☐	☐	☐
Port	Transfer removed piles directly from the water to a containment basin on the barge or uplands. Containment basins may be durable plastic sheeting supported by straw bales. Do not discharge water in basins to waters of the state.	☐	☐	☐

SBE CM or Other Source	Description	Meets	Does Not Meet	Not Applicable
Port	Dispose of piles and sediment removed during pulling of piling at an approved upland disposal site.	☐	☐	☐

Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment D. Generalized Construction Sequence

Port of Seattle Bankline Repair and Enhancement Program NWS-2018-780-WRD

Generalized Construction Sequence

December 2018

PROJECT EXECUTION PROCESS

This document serves to outline basic steps that the Project Team, including Port staff, contractors, and consultants, will use to successfully complete project construction in a manner that complies with the programmatic approval. Each repair and enhancement project is completed in a series of steps, as listed below:

- Pre-Construction Planning
- Site Preparation and Mobilization
- Construction
- Site Clean-up and De-mobilization
- Project Closeout and Reporting

With the exception of the construction phase, each of the following sections provides general steps that will be undertaken for each project. The construction portion of this document is organized to present a comprehensive list of best management practices, not all of which may be applicable.

Pre-construction Planning

1. Submit plan set (including TESC plan and SWPPP) to agencies and tribes for approval at least 60 days prior to anticipated construction.
2. Provide project-specific compliance manual to contractor, Resident Engineer, and Environmental Agent.
3. Hold a pre-construction meeting with Port Resident Engineer, Construction Contractor, Environmental Compliance Manager, and relevant (sub)contractors to discuss the following:
    a. Contract requirements
    b. Scope of work/Plans
    c. Project-specific constraints
    d. Permit conditions
    e. Environmental Health and Safety Plans
    f. Schedule
4. Ensure personnel have required security clearances for site access.

Site Preparation and Mobilization

1. Port Representative and Contractor will meet on-site to verify that the following have been clearly identified for construction personnel:
    a. Security and site access
    b. Staging and stockpile locations
    c. Clearing and grading limits demarcation
    d. Tree retention buffer demarcation
    e. Environmentally sensitive/critical areas delineations, including OHWM, if applicable
    f. Contact information for environmental monitoring and inspection personnel
2. Verify installation of TESC measures, spill prevention, and containment and countermeasures, per plan approved by agencies and tribes.
3. The Port of Seattle will give contractor notice to proceed with construction
4. Mobilization, potentially including:
    a. Heavy equipment
    b. Other machinery
    c. Construction materials
    d. Construction trailers
    e. Sanitary facilities
    f. Traffic control
    g. Other associated preparations necessary for construction

Construction While bankline repair and maintenance projects are generally routine and predictable, construction practices will vary based upon existing conditions, proposed treatment type and location, and seasonal variations. Below is a generalized construction sequence for the different types of construction activities that may be proposed under the programmatic. Attachment C provides a comprehensive conservation measure checklist for ease of use.

1. In order to avoid and minimize potential negative effects on fish and wildlife and water quality, work below the OHWM in estuarine or marine zones will be conducted, whenever feasible, during periods when the work site is exposed by tide. Active shoreline repair and maintenance activities will maintain a minimum of two vertical feet or six feet horizontal separation from tide level. In no circumstances will shoreline repair and maintenance activities take place below OHWM during periods of extreme wind, rain, and wind-generated waves.
    a. Work may progress as the tide allows, beginning at the upslope side of the bank and progressively working downslope as the tide ebbs.
    b. Any exposed bank soil will be back-bladed, smoothed, and covered with fastened erosion control fabric prior to tidal inundation.
    c. Excavation and material placement will be sequenced to ensure that interim project slopes are free draining and not irregular. This will minimize the risk of fish and wildlife entrapment during tidal cycles.

2. If project scope and work conditions prevent work during low water periods, the Port will determine if a containment boom or turbidity curtain is necessary to isolate the work area.
    a. If necessary, a floating, flexible control barrier, functioning as a float boom, suspending a ballast-weighed turbidity curtain will be installed. The boom, with turbidity curtain, will isolate the work site, anchored at each end of the repair and maintenance area, forming a continuous surface to bottom barrier. The turbidity curtain will remain in place until the turbidity within the work area has returned to background levels.
    b. Any pumped water discharged to waters of the state will substantively comply with NPDES construction requirements including monitoring to confirm compliance with applicable water quality standards
    c. Once in-water work is complete, turbidity curtains or containment booms will be removed from the site.

Pile replacement/removal

1. Equipment may include an upland-based and/or barge mounted vibratory or impact pile driver. Instances when removal of piling is an element of the bankline repair and enhancement scope of work, will include use of a vibratory pile driving device for extraction of piling, consistent with 2007 Puget Sound region "Best Management Practices for Pile Removal and Disposal".
2. Marine mammal observers will be stationed as required by the marine mammal monitoring plan for pile removal and replacement activities during all vibratory removal and replacement.
3. Removal
    a. A barge or deck mounted crane and pile driver is positioned to remove or replace the pile.
    b. Piles are extracted from the substrate using a vibratory device and crane hoist. The vibratory device is used to loosen each pile and raise the pile approximately 10 feet. A chain and cable rigged to an overhead crane boom will pull the pile vertically, removing it from the substrate and water column to an adjacent barge of upland containment area.
    c. If wooden piles cannot be removed with vibratory extraction, they will be cut at the mudline using a chainsaw.
    d. Clean sand will be placed as a fill cap at each location were piling are extracted. The sand fill cap will be limited to approximately five feet diameter and six inches in depth (approximately 0.36 cubic yards of clean sand fill for each removed piling). The sand cap will adequately fill the substrate void remaining from piling removal. In the instance where piling cannot be successfully extracted, the clean sand cap will serve to cover the remaining below-grade piling, isolating the cut piling head from adjacent substrate area. Sand cap material will be placed using a clamshell

bucket lowered through the water column, releasing the sand at the substrate level.

e. Extracted/removed piling will be stockpiled in a controlled, confined receiving area, aboard a specially prepared barge on in upland area, preventing sediment-laden water from entering aquatic area. Extracted/removed piling will be reduced to maximum four feet lengths, as required by 2007 piling removal conservation measures. All piling materials will be transferred to an approved disposal site or wood waste re-use/recycling facility.

4. Replacement
   a. Replacement sheet piles will be delivered to the project site and stockpiled on the barge or an upland location.
   b. Sheet piling will be installed with a vibratory device whenever possible. An impact hammer may be used to proof piles, if needed. Noise attenuation devices will be installed prior to impact pile driving.
   c. Following installation, replacement sheet piling may be fitted with vertically oriented ultra-high molecular weight (UHMW) plastic friction strips.

Removal of material

1. Where feasible, utilities will be relocated from the work area.
2. Material will be excavated to the required depth.
3. Excavated material will be exported to the prepared, confined stockpile area for later transport to an approved disposal site or reuse depending on the soil characteristics and needs of the project. Stockpile areas will be prepared for stormwater and excavated material drainage control to prevent the release of sediment-laden water to adjacent aquatic areas.

Structural repair

1. Vertical bulkhead:
   a. Sheet piling repair and maintenance will be limited to documented previously approved dimensions. Auger-cast piling may be used along with sheet piling, concrete panels, or heavy timber lagging installed to create the wall. If necessary, tie-backs will be installed at intervals along the sheet piling and attached to earth anchors located landward of the structure. If necessary, aggregate backfill and drainage piping may be installed to relieve hydrostatic pressures behind such walls. Structural backfill and a drainage system will be placed behind the sheet piling. Clean aggregate or fractured rock will be placed in the excavated toe along the waterward face of the sheet piling.
   b. Concrete bulkheads may be repaired as follows. The broken edge of the bulkhead is exposed by removing encrusting marine growth, steel bars are embedded in the bulkhead (if the original bars are damaged or destroyed), a form is built and sealed, and the form is filled with fast-curing concrete, with no discharge of concrete or grout material to adjacent shoreline or aquatic area. For tidal waters, concrete is

placed into the forms as soon as the tide recedes below the lowest part of the repair. The form is left in place, through several tidal cycles if needed, until the concrete is fully set. Once the concrete is set, the forms are removed when they are exposed by low tide. A drainage system is installed as needed. Filter fabric is placed in the excavated area behind the bulkhead, and the area is backfilled with clean crushed rock/select fill material. If appropriate, substrate material (e.g., fish habitat mix) is placed waterward of the bulkhead.

c. Where the area landward of a vertical bulkhead requires repair, the area behind the bulkhead is excavated by open cuts, shoring, and/or casing. Holes are drilled, casing is placed, steel H-beams are positioned into the holes, and the holes are backfilled with concrete. If necessary, additional drainage is provided by installing new drainage holes or a new lateral perforated drain pipe sloped to a suitable discharge location. Filter fabric is placed along the landward face of a bulkhead with weep holes and/or around the lateral drain system. After the concrete backfill around the soldier piling is cured, free-draining structural backfill is placed behind the wall and compacted.

2. Conventional Armored Slope:
   a. If the toe of a bulkhead is exposed or undermined, the eroded area is filled with new material, large enough to resist erosive forces, within the “footprint” and dimensions of the previously approved bankline. The replacement material is placed and spread in the affected area by an excavator operated from the uplands or a barge-based crane.
   b. If rock material has been displaced from a bulkhead or the rock material has settled, the displaced material is reset and, if necessary, new clean material is placed into the bulkhead. The displaced rocks are grabbed by excavator or crane and repositioned into voids in the bulkhead. The heavy equipment is either operated from the barge or from uplands. Small voids or irregularities in the repaired slope may remain to optimize habitat opportunities where conditions allow. Where voids need to be filled to support durable conditions, they may be filled with new rock, riprap, spalls, crushed rock, or clean sand and aggregate.
3. Alternative stabilization will be implemented through regrading of banks, placement and anchoring of large woody debris, removal/management of invasive weeds, topsoil amendment or import and planting of native revegetation.
   a. Large woody material may be installed and anchored into the substrate using earth anchors, rock bolsters, or crib-wall structures.
   b. Planting
      i. Specified native plants will be installed in the period from October to March.
      ii. Intertidal marsh and riparian habitat zones will be densely planted with native species.
      iii. Riparian plantings
         1. Plantings will be bare root stock.

2. Plantings will be installed into a 2-foot layer of imported topsoil, covered with plant fiber fabric.
3. Plantings will be covered with six to eight inch layer of mulch.
4. Temporary irrigation system will be installed to ensure riparian plant establishment.

iv. Emergent marsh plantings

1. Plantings will be root plugs or bare root shoots.
2. Plantings will be installed in biodegradable fabric pillow with two-feet of fine grain sediment mix.
3. Goose exclusion fencing will be installed to allow for successful establishment.

c. Eelgrass and kelp establishment

i. Eelgrass and kelp will be transplanted from nearby sources in Elliott Bay and Shilshole Bay. No more than 10% of eelgrass turions or kelp holdfasts will be removed from a given area for transplantation.
ii. Eelgrass transplantation will follow "Guidelines for Conservation and Restoration of Seagrasses in the United States and Adjacent Waters" (Fonseca et al. 1998).
iii. Eelgrass transplant methods may include plug transplants, staple or staked transplants, or biodegradable potted transplants.
iv. Kelp may be transplanted by securing holdfasts or inoculated twine to appropriately sized clean cobble stone or other anchoring material.

Site Clean-up and Demobilization

1. All debris and stockpiles will be removed from the site.
2. Temporary staging and stockpiling areas will be restored to their original state or better.

Project Closeout and Reporting

Following completion of construction, the Port will prepare as-built documentation for each project, which will describe any deviations from design plans. The Port will maintain as-built documentation in its project data tracking system. Summary statistics from each project will be included in a year-end report to permitting agencies of all bankline projects.

Projects will be monitored and maintained to ensure they meet project objectives, as described below.

Monitoring

Monitoring will be conducted by Port staff or a qualified third-party representative. The frequency and duration of monitoring will vary depending on type of project, as described for each monitoring parameter below. A monitoring report or memorandum will be prepared in each year of the program to provide a brief summary of conditions and any recommendations for further maintenance or repair necessary to meet performance standards.

Port-controlled banklines will be evaluated on a three-year rotation to ascertain repair and maintenance needs. The evaluations will be used as the basis for prioritizing repair and maintenance needs.

The following describes post-construction monitoring standards, methods, and schedule for different types of bankline treatments included in the program. Vegetation monitoring parameters and standards described below apply to vegetation restoration areas less than one acre in size. An individual vegetation monitoring plan will be developed and implemented for any plan with an area of revegetation greater than one acre.

Monitoring Parameter: Slope Erosion and Bank Integrity

1. Type of Treatment: All
2. Performance Standard: No evidence of significant erosion or bankline instability after a period of initial site stabilization.
3. Monitoring Task: Visual inspection and photo points
4. Methods: In Year 0, establish permanent photo points throughout the site. During subsequent monitoring years, visually assess the site for areas of erosion and document these areas using permanent photo points, supplemented by additional photos as needed to represent the area of concern.
5. Schedule: Year 0, Year 1, and Year 3, following winter season.
6. Contingency measures: Erosion that causes gross deviations in site contours or otherwise compromises the functions of the site will be stabilized by non-structural approaches such as vegetation, fiber mats, or other “soft” engineered options to the extent possible. Structural approaches may be used if non-structural approaches are not feasible.

Monitoring Parameter: Survival of Riparian Vegetation

1. Type of Treatment: Any treatment that includes riparian planting
2. Performance Standard: Survival of planted woody species shall be at least 50 percent at Year 3. This standard can be satisfied through plant establishment, recruitment of native volunteers, or replanting as necessary to achieve the required quantities.
3. Monitoring task: Vegetation survival survey
4. Methods: Count all woody plants within the project area or within a designated sub-sample area for large sites. Note any issues limiting plant survival or growth, such as herbivory, disease, or lack of adequate water supply.
5. Schedule: Conducted in the late growing season at Year 1, 3, and 5.
6. Contingency measures: Excessive failure rates (less than 75 percent survival in any single monitoring year) will be addressed by secondary planting if appropriate, and if causal factors of failure can be determined, they will be corrected. Site-specific variables (e.g. light availability, soil moisture, nutrient availability, wildlife browsing, or weed competition) will be considered in proposing appropriate plant substitutions. Plant substitutions resulting from wildlife browse may include species known to be less desirable to targeted wildlife species. Wildlife exclusion devices may be installed, as

required, to protect individual plantings or planting areas. Damage to such devices caused by logs, trampling, or geese will be immediately repaired.

Monitoring Parameter: Areal Coverage of Riparian Vegetation

1. Type of Treatment: Any treatment that includes riparian planting
2. Performance Standard: Areal coverage of native riparian vegetation shall be at least 50 percent by Year 3 and 75 percent by Year 5.
3. Monitoring task: Vegetation cover estimate
4. Methods: Visually estimate areal cover of native vegetation within planted area.
5. Schedule: Years 3 and 5 following the growing season (September or October)
6. Contingency measures: Evidence of plant failure or failure to meet expected recruitment rates will trigger appropriate actions including determining the cause of failure and making needed project adjustments and increasing maintenance activities such as including removal of invasive species and/or replanting.

Monitoring Parameter: *Areal Coverage of Marsh Vegetation*

1. Type of Treatment: Any treatment that includes marsh planting
2. Performance Standard: Areal coverage of native marsh vegetation shall be stable and improving within portions of the project with elevations suitable for marsh establishment (+8 feet to +12 feet MLLW).
3. Monitoring task: Vegetation cover estimate
4. Methods: Visually estimate areal cover of native marsh vegetation within planted area. Collect photo points established during Year 0.
5. Schedule: Years 0 (photo points established) and Years 1, 3, and 5, late growing season.
6. Contingency measures: Evidence of plant failure or failure to meet expected recruitment rates will trigger appropriate actions including determining the cause of failure and making needed project adjustments and increasing maintenance activities such as including removal of invasive species and/or replanting.

Non-compliance Response

During construction, Port inspection personnel or (an) authorized designee(s) will document that work is done according to plans and permit requirements. Inspection summary reports will be prepared for each site visit made by an inspector. If work does not meet approved plan or permitting requirements, work will be suspended until a successful solution to the non-compliance issue is developed and implemented.

During post-construction monitoring, failure to meet performance standards will be addressed by supplementing the previous action, if appropriate. If causal factors of failure can be determined and addressed, they will be corrected as soon as feasible, with consideration for the severity and potential impacts of failure.

Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment E. Water Quality Monitoring and Protection Plan

Programmatic Water Quality Monitoring and Protection Plan (WQMPP)

Bankline Repair and Enhancement Multi-Site Program NWS-2018-780-WRD

Port of Seattle

December 2018

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The Watershed Company

Title-page image: View of alternative shoreline stabilization at Centennial Park, Seattle, WA.

Report Disclaimer: The information contained in this report is based on the application of technical guidelines currently accepted as the best available science. All discussions, conclusions and recommendations reflect the best professional judgment of the author(s) and are based upon information available at the time the study was conducted. All work was completed within the constraints of budget, scope, and timing. The findings of this report are subject to verification and agreement by the appropriate local, state and federal regulatory authorities. No other warranty, expressed or implied, is made.

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Appendix A

Water Quality Monitoring Data Form

Port of Seattle Programmatic Water Quality Monitoring and Protection Plan (WQMPP)

1. Background, Purpose, and Applicability

1.1 Overview of the Port of Seattle Bankline Repair and Enhancement Program

The Port of Seattle (Port) Bankline Repair and Enhancement Program (Program) will establish a systematic process for enhancement of shoreline environmental functions while maintaining the structural integrity and stability of Port-controlled banklines. Specifically, the program will maintain and improve the following functions:

- Shoreline environmental functions, including improvement of riparian and aquatic habitat, enhancement of water quality, and improvement of bankline resilience;
- Protection of Port facilities from slope failure, structural decline and other degradation; and
- Public shoreline access to publicly-owned shorelines and open space.

The Port routinely engages in bankline repair and enhancement activities to address these objectives along approximately 15.4 miles of Port-controlled shoreline facilities in the Seattle area. These activities have included in-kind replacement of existing hard stabilization materials, such as riprap and vertical bulkheads, as well as enhancement with alternative stabilization techniques, such as slope regrading, anchored wood, riparian and emergent marsh plantings, subtidal substrate enhancement, and other soft shoreline rehabilitation techniques. In most cases, each of these past projects was permitted individually, resulting in duplicative effort by the Port and regulatory agency staff.

Future bankline repair and enhancement activities will continue to be needed regardless of whether they are covered under programmatic or individual authorizations. Repair and enhancement activities will encompass a range of activities with varied levels of potential effects to water quality, as follows:

1. Activities conducted entirely landward of or above the elevation of Ordinary High Water (OHW) or Mean Higher High Water (MHHW);
2. Activities conducted entirely in-the-dry between tide cycles and projects with limited sediment disturbance, such as vibratory pile removal, plantings, and manual work in-water; and
3. Other in-water activities.

Three levels of water quality monitoring are proposed in this plan to account for the different levels of risk associated with the different types of project.

Long-term programmatic authorizations provide a more efficient regulatory approach since they reduce redundancy, saving resources and time for both the Port and agencies, while avoiding and minimizing potential negative environmental effects. A programmatic approach also lends consistency and predictability across projects and allows the Port to leverage its considerable experience to maximize environmental improvements. The program will enable the Port to use repair and enhancement activities that are critical to Port actions as tools to contribute to the Port's Century Agenda goal of restoring, creating, or enhancing 40 additional acres of habitat in the Green-Duwamish watershed and Elliott Bay.

The Program does not allow the conversion of unarmored shoreline to an armored shoreline. The Program does not apply to expanded hard bankline stabilization structures and is strictly limited to repair and enhancement of existing structures. New structures, when needed, will be reviewed separately.

1.2 Port of Seattle Sites and Conditions

Port-controlled sites occur in three geographic areas distinguished by adjacent water body types as follows:

- Estuarine- Duwamish Waterway (including the East Waterway, and West Waterway)- River miles 0.0 to 5.0)
- Marine- Elliot Bay and Puget Sound
- Freshwater- Lake Washington Ship Canal and Salmon Bay

The proposed programmatic activity will apply at all of 29 Port- controlled shoreline facilities in the Seattle area (Figure 1), and may also apply to existing structures at additional sites as and if acquired. Water quality monitoring and protection approaches and requirements will differ somewhat based on adjacent water bodies, as well as the

type of repair or enhancement proposed. As applicable, these differences are identified under **Water Quality Monitoring**, in Sections 4 and 5, below.

In addition to this WQMPP, all bankline repair and enhancement activities conducted as part of this Program within CERCLA or MTCA designated cleanup sites would be coordinated with the EPA, and/or Ecology, and will be designed to not preclude or foreclose future cleanup options. The following locations would need EPA and/or Ecology concurrence prior to project approval:

- Terminal 91
- Terminal 18
- North end of Terminal 5 and Pier 2
- Terminal 10
- All properties along the Duwamish Waterway
- All properties along the East Waterway

2. Project Activities

The Program will apply only to repair and enhancement of existing bankline stabilization features and structures, and/or to implement projects or project elements contributing to the enhancement ecological functions. Existing and proposed bankline conditions are characterized as two categories, "hard stabilization" and "alternative stabilization", as listed below. A given project may combine multiple design components from either or both categories to achieve the preferred post-project bankline conditions.

A. Hard Stabilization

1. Rubble-strewn Bank
2. Conventional Armored Slope
3. Step Wall Bulkhead
4. Sloped Bulkhead and Boat Ramp
5. Bulkhead and Conventional Armored Slope
6. Vertical Bulkhead

B. Alternative Stabilization

1. Top of Slope Riparian Buffer
2. On-slope Riparian Buffer

3. Transition Anchor System
4. Emergent Marsh Bed
5. Natural Beach
6. Intertidal or Subtidal Bench

Overwater structures, derelict piles, and debris may be present in conjunction with any of the shoreline treatments. The presence of an overwater structure may affect bankline repair and maintenance needs and associated designs appropriate for a given site. Removal of derelict piles or debris at or immediately waterward of the bankline repair and enhancement project is included in the proposed program WQMPP.

For a given bankline repair and enhancement project, Port staff will prepare project-specific drawings along with a complete project notification, which will be submitted to permitting agencies at least 60 days prior to anticipated construction.

3. Conservation Measures

The Port has identified standard conservation measures applicable to bankline repair and enhancement at the Port of Seattle properties, which are included in Attachment C. The following measures from Attachment C relate directly to protection of water quality. For projects with a ground disturbance area greater than one acre, a construction stormwater pollution and prevention plan will be prepared and followed.

3.1 Spill Prevention and Response

- Care will be taken to prevent any petroleum products, chemicals, or other toxic or deleterious materials from entering the water. Fuel hoses, oil drums, oil or fuel transfer valves and fittings, etc., will be checked regularly for drips or leaks, and shall be maintained and stored properly to prevent spills into State waters. Proper security shall also be maintained to prevent vandalism.
- Vegetable-based hydraulic fluid will be used in pile driving equipment.
- Contractors will maintain a spill containment kit, including oil-absorbent materials, on site to be used in the event of a spill or if any oil product is observed in the water.
- If a spill occurs, work would be stopped immediately, steps would be taken to contain the material, and appropriate agency notifications would be made. The contractor will be responsible for the preparation of spill response and hazardous material control plans to be used for the duration of project construction.

- Spills and/or conditions resulting in distressed or dying fish will be reported immediately to Ecology's Northwest Regional Spill Response Office at (425) 649-7000, the Washington Emergency Management Division at (800) OILS-911, and the National Response Center at (800) 424-8802.
- If fish are observed in distress or a fish kill occurs, work would be stopped immediately. WDFW, Ecology and other necessary agencies would be contacted and work would not resume until further approval is given.

3.2 Temporary Erosion and Sediment Control Plan

Each maintenance or repair activity will include a Temporary Erosion and Sediment Control (TESC) Plan as applicable. These plans will provide specific guidance on site construction fencing, silt fencing, tree protection fencing and other applicable TESC features and procedures. Sediment and erosion control measures will be inspected and maintained prior to and during project implementation, and will be removed upon project completion.

The project will also comply with local jurisdiction standard clearing, grading, and temporary erosion control notes. All projects will be approved by the local municipalities prior to construction.

3.3 In-water Work

- The timing of in-water work will be approved by Washington Department of Fish and Wildlife, US Fish and Wildlife Service, and the National Marine Fisheries Service, to minimize the likelihood of presence of sensitive fish species.
- Onsite oil absorbing floating booms will be used to surround the work area when equipment operates below the OHW or MHHW.
- Debris will be collected and disposed of at an approved upland location.
- Equipment operating below the OHW or MHHW will use vegetable-based hydraulic fluid.
- Wash water containing oils, grease, and other materials will be contained for proper disposal.
- Equipment operating below the OHW or MHHW will be confined to designated access corridors.
- Construction barges will not be allowed to ground or rest on substrate or vegetation. Vessels will be operated with combined minimal propulsion

power and maximum water depths to avoid propeller scour damage or turbidity.

- Where cured-in-place concrete is needed, the project will avoid potential impacts from exposure to uncured concrete by allowing concrete to cure set for at least 24 hours prior to removal of forms and exposure to seawater. Projects will avoid in-water use of glue, epoxy, or other adhesive compounds.
- Only clean, washed material will be used for imported fill.

3.4 Piling Removal/Replacement Water Quality Measures

- Piling treated with creosote, pentachloraphenol, or coal tar will not be used. ACZA-treated timber piles shall only be used to replace existing treated timber piles, and only when no other material is practicable as determined by an engineering analysis.
- Hydraulic water jets will not be used to remove or place piling
- All treated wood removed will be contained on land or barge to preclude sediments and contaminated material from entering water.
- Repair/maintenance of pile caps, beams, rub strips, wraps, and blankets will be conducted in the dry.
- Only environmentally safe products will be used for pile cleaning.
- Cathodic protection for sheetpile will be installed manually using divers.
- Aluminum anodes will be used for cathodic protection where needed.
- A vibratory hammer will be used whenever possible to replace sheetpile. An impact hammer may be used to proof piles, if needed.
- A bubble curtain or other attenuation device will be deployed during impact pile driving to protect marine life.
- If piles break during removal and cannot be mechanically extracted, they will be cut off at the mudline and capped with 6-inches of clean sand.
- Removed piles will be transferred directly from the water to a containment basin on a barge or uplands. Containment basins may be durable plastic sheeting supported by straw bales. Water in basins will not be discharged to waters of the state.
- Piles and sediment removed during pulling of piling will be disposed of at an approved upland disposal site.

3.5 Construction Sequencing

The Generalized Construction Sequence (Attachment D) describes the process that will be used before, during, and following construction to avoid and minimize potential environmental impacts, including impacts to water quality, and to ensure environmental regulatory compliance. This construction sequence builds on many of the conservation measures in Attachment C to avoid and minimize impacts. It also includes a description of post-construction monitoring standards, methods and schedule for different types of bankline treatments included in the program. A monitoring report or memorandum will be prepared in each monitoring year of the program to provide a brief summary of conditions and any recommendations for further maintenance or repair necessary to meet performance standards.

4. Applicable Water Quality Standards and Parameters

Programmatic repair and enhancement will be consistent with Chapter 173-201A WAC for turbidity monitoring. Proposed project actions, with accompanying best management practices, are not expected to measurably affect temperature, dissolved oxygen, bacteria, or pH; therefore, turbidity is the only water quality parameter proposed for monitoring.

The applicable turbidity standards for surface waters in the different project zones are described in Table 1.

Table 1. Water quality standards and turbidity criteria in the different zones within the project area per WAC 173-201A.

Waterbody	Description of Area	Aquatic Life Uses	Turbidity Criteria
Duwamish Waterway	From the mouth south of a line bearing 254 degrees true from the NW corner of berth 3, terminal 37, upstream to the Black River (RM 11.0)	Rearing/ migration only	Turbidity shall not exceed 10 NTU over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
Elliott Bay	East of a line between Pier 91 and Duwamish Head	Excellent	Turbidity must not exceed 5 NTU over background when the background is 50 NTU or less, or

Waterbody	Description of Area	Aquatic Life Uses	Turbidity Criteria
Puget Sound	South to 122°55'30" and west to longitude 122°51'W	Extraordinary	a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Lake Washington Ship Canal	Between Government Locks and Lake Washington.	Core summer habitat	Turbidity shall not exceed 5 NTU over background when the background is 50 NTU or less, or a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

5. Water Quality Monitoring

The following section describes the water quality monitoring protocols proposed for bankline repair and maintenance activities.

5.1 Contact Information

The Port of Seattle Environmental Compliance Manager or representative will be responsible for providing Ecology with the necessary notifications and results of the water quality monitoring per the frequency specified in Section 401 of the Clean Water Act. Office: 206.787.3344, Mobile: 206.612.4805

The Environmental Compliance Manager or representative will be conducting the Section 401 water quality monitoring.

5.2 Sampling Procedures by Project Type

5.2.1 Level 1 -- Standard Water Quality Monitoring and Protection

For all projects, prior to construction, the Port will ensure that construction contracts contain language that requires the contractor, Resident Engineer, and Environmental Compliance Manager review the project limits, environmentally sensitive areas, and applicable measures to protect water quality, including temporary erosion and sediment control and spill prevention, containment and countermeasures. Port contractors and Port monitoring and inspection personnel will report any spills or other water quality impacts to appropriate permitting agencies. Activities conducted entirely landward of or

above the elevation of OHW or MHHW will not require additional water quality monitoring.

5.2.2 Level 2 -- Actions Requiring Visual Monitoring

In addition to standard Water Quality Monitoring and Protection measures, described above, actions conducted entirely in-the-dry between tide cycles. These types of projects will require visual monitoring of turbidity during project activities and for one hour following tidal inundation of the work area (for work conducted between tide cycles).

Visual monitoring will also be required for projects with limited sediment disturbance, such as vibratory pile removal, plantings, and manual work in-water. Visual monitoring is sufficient for pile removal based on a demonstrated lack of water quality impact through the Port's history of monitoring pile removal, including recent experience from the removal of thousands of piles at Terminal 5, where no detectable changes in water quality parameters were observed.

Visible turbidity will be considered an exceedance of the water quality standard if visible turbidity extends anywhere at or beyond the established mixing zones, described in Section 5.3.

5.2.3 Level 3 -- Actions Requiring Sampling

Actions conducted in water, other than described in Section 5.2.2, will require water sampling to confirm that turbidity falls within established thresholds. Continuous visual monitoring will also be conducted at these sites.

Turbidity will be monitored using a Hydrolab Minisonde portable water quality meter, YSI, or similar device, with the capability of obtaining direct field data for turbidity.

A portable water quality meter will be used in the field. The measurements will either be taken by a submersible or via staff. A representative sample will accurately reflect the true condition of the water source from which the sample was taken. The following protocol could be used to ensure a representative sample is analyzed:

- Use a clean container to obtain a grab sample from the source;
- Collect sample with care to avoid disturbance of sediments and collecting surface contaminants;
- Gently but thoroughly mix the sample before pouring it into the small vial used to read the sample in the turbidimeter; and

- Without allowing the sample to settle, take turbidity reading according to turbidimeter manufacturer's instructions.

A calibration check of the turbidity measurement device using secondary standards will be carried out regularly (at least once per week). The instrument will be recalibrated using primary standards at least once every 3 months, or more when a calibration check indicates there is a problem. The manufacturer's calibration procedures will be followed.

5.3 Mixing Zones and Sampling Locations

5.3.1 Duwamish Waterway

Since the Duwamish Waterway is tidally influenced, it will be considered marine water for turbidity sampling. The mixing zone is a 150-foot radius surrounding the in-water activity. Sampling locations for in-water work along the Duwamish Waterway will be located 150 feet along the shore in each direction from the work area.

5.3.2 Elliott Bay and Puget Sound

The marine mixing zone is a 150-foot radius from in-water activity. Sampling locations for in-water work along Elliot Bay and Puget Sound will be located 150 feet along the shore in each direction from the work area.

5.3.3 Lake Washington Ship Canal

Consistent with Ecology's previous Water Quality Certification for Multi-site Phased Pile Systems Repair and Maintenance, the mixing zone in the Lake Washington Ship Canal will be considered to be 300 feet downstream from the in-water activity.

Two sampling locations will be used for in-water work along the Lake Washington Ship Canal. Sample Location 1 (background location) will be located 100 feet upstream of the in-water work. Sample Location 2 (compliance location) will be located 300 feet downstream of the in-water work.

5.4 Sampling Frequency

Where physical sampling is required, background turbidity samples will be taken at the identified sampling locations 30 minutes before the contractor begins in-water work. Subsequent samples will be taken within one hour of the commencement of in-water work, at least twice daily during active work periods. In addition, under tidal conditions, samples will be taken at slack water, where possible, or near daily high and low tide conditions.

In locations with tidal influence, the up-current location will provide the background turbidity, and the down-current location will provide the compliance turbidity. For slack-water samples, up- and down-current will be determined for the period immediately preceding sampling.

At all sites, reference and compliance samples should be taken in quick succession and compared to determine compliance.

5.5 Monitoring Period and Duration

Monitoring will be conducted at the locations and frequencies as specified above on the first two days of each type of in-water work task (i.e., grading, planting, armoring). If all samples taken are in compliance, instrumented sampling will cease unless there is a visual indication of turbidity.

Visual monitoring will be conducted continuously when any work below the OHWM occurs, and shall continue for one hour after inundation of the work area for projects in the tidal zone.

5.6 Contingency Sampling

If either visual monitoring or physical sampling indicates an exceedance of water quality standards, the following steps in sequence are to be taken to resolve the exceedance:

1. The water quality inspector will notify the contractor of the exceedance and also notify and work with the Port Project Engineer as needed to immediately stop or modify the work causing the exceedance;

2. The required emergency notification reporting will be initiated.

3. Sampling will continue on an hourly basis until standards are met for two consecutive sample periods;

4. The Environmental Compliance Manager, Port Project Engineer, and the Contractor will meet promptly to discuss and come to agreement on ways to adjust in-water work methods or means such that exceedances are corrected. Additional conservation measures may be used as available to prevent the exceedance from continuing or recurring.

5. In- water work will resume when sampling indicates that the exceeded parameter(s) are back in compliance.

6. Notification and Reporting

The applicant will notify the Department of Ecology of proposed work in writing at least 30 days prior to the start of in-water activities. The notification shall include project plans and the applicable water quality monitoring procedures to be used.

All water quality monitoring results (visual and physical) will be recorded on an approved monitoring form, sample(s) attached (Appendix A). All sample results will be submitted to the Ecology Federal Permit Coordinator/Manager per the frequency specified in the Section 401 permitting documents.

If sample results indicate an exceedance of water quality standards, notification shall be made within 24 hours to Ecology's Federal Permit Manager/Coordinator. Such notification shall include a description of the nature and cause of the exceedance, the period of non-compliance, and steps taken and to be taken to reduce, eliminate, and prevent recurrence of non-compliance.

APPENDIX A

WATER QUALITY MONITORING DATA FORM

Date: _____ Project Location: _____

Name of Person Sampling: _____ Date of last calibration for Turbidity Meter: _____

Activity Description: _____Activity Start Time: _____ Activity Stop Time: _____

For Marine/Estuarine Waters: Time of Daytime Low Tide _____ Time of Daytime High Tide_____

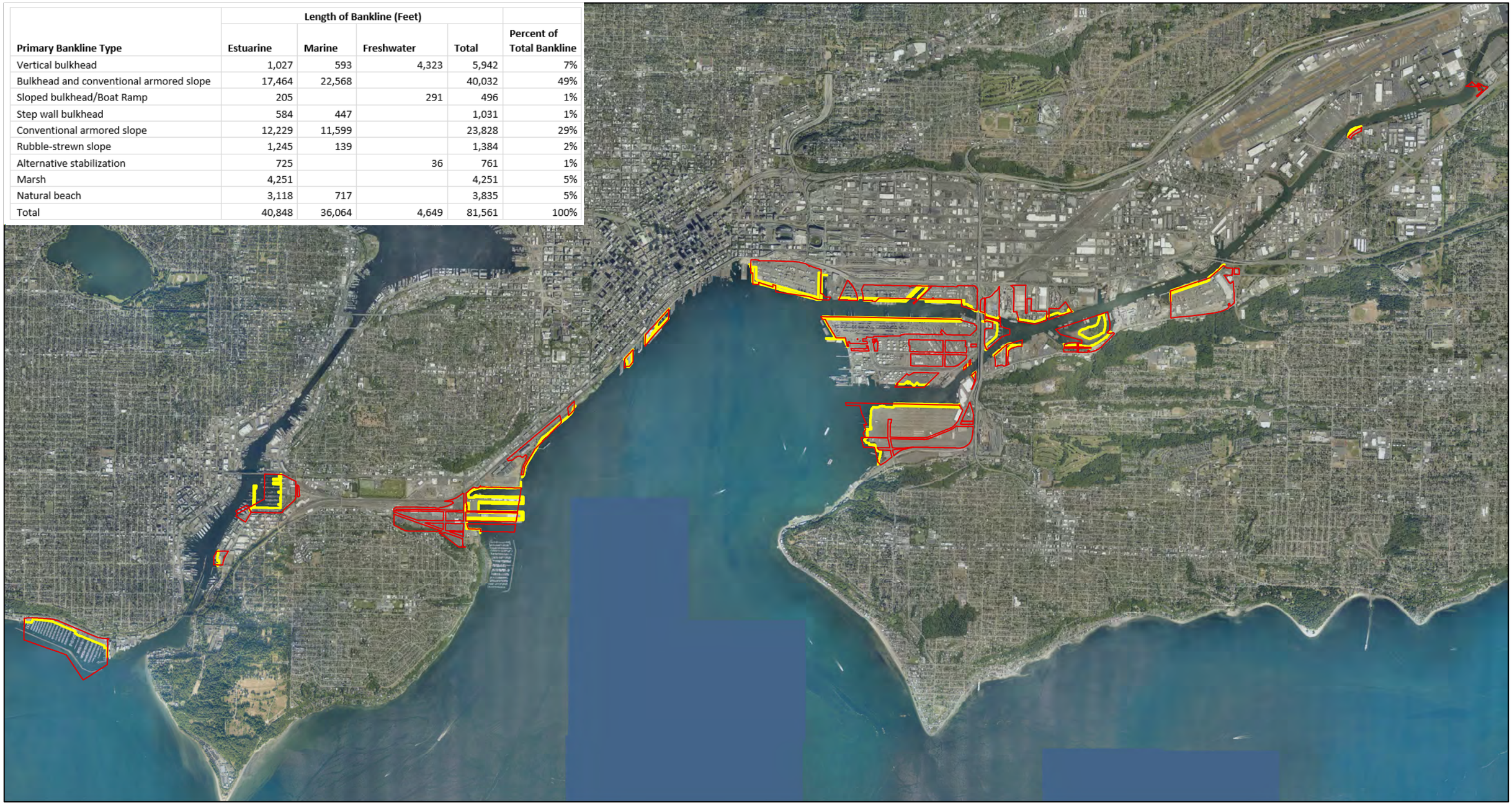
Upcurrent Sample			Downcurrent Sample			Weather conditions	Turbidity Increase from Upcurrent to Downcurrent (NTU)	Allowable Increase (NTU)	Standard Exceeded? (Y/N)*	Contractor Notified? (Y/N)
Location Relative to Project Activity	Time	Turbidity (NTU)	Location Relative to Project Activity	Time	Turbidity (NTU)					
Corrective Measures taken by Contractor (if turbidity levels exceed State standards):										
Other Comments:										

** Clearing & Grading Inspector must be notified by telephone if standard is exceeded.*

Port of Seattle Bankline Repair and Enhancement Multi-site Program

Attachment F. Mapbook of Port banklines

Primary Bankline Type	Length of Bankline (Feet)				Percent of Total Bankline
	Estuarine	Marine	Freshwater	Total	
Vertical bulkhead	1,027	593	4,323	5,942	7%
Bulkhead and conventional armored slope	17,464	22,568		40,032	49%
Sloped bulkhead/Boat Ramp	205		291	496	1%
Step wall bulkhead	584	447		1,031	1%
Conventional armored slope	12,229	11,599		23,828	29%
Rubble-strewn slope	1,245	139		1,384	2%
Alternative stabilization	725		36	761	1%
Marsh	4,251			4,251	5%
Natural beach	3,118	717		3,835	5%
Total	40,848	36,064	4,649	81,561	100%



Bankline Rehabilitation and Enhancement Multi-Site Program

0 0.5 1 mi

Port-Owned Parcel Boundary
Bankline

Existing Bankline Characterization

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 125 250 ft

Port-Owned Parcel Boundary

Primary Conditions
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure

Shilshole Bay Marina - North

1

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 140 280 ft

Port-Owned Parcel Boundary

Primary Conditions

Step wall bulkhead

Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Shilshole Bay Marina - South

2

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 80 160 ft

Port-Owned Parcel Boundary

Primary Conditions
Vertical bulkhead
Alternative stabilization

Secondary Conditions
Overwater structure
Riparian

Maritime Industrial Center

3

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 75 150 ft

Port-Owned Parcel Boundary
Primary Conditions
Vertical bulkhead
Secondary Conditions
Overwater structure

Salmon Bay Marina

4

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 200 400 ft

Port-Owned Parcel Boundary
Primary Conditions
Vertical bulkhead
Sloped bulkhead
Secondary Conditions
Overwater structure

Fishermen's Terminal

5

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 240 480 ft

Port-Owned Parcel Boundary

Primary Conditions
- Vertical bulkhead
- Natural beach
- Conventional armored slope
- Bulkhead and conventional armored slope

Secondary Conditions
- Overwater structure
- Riparian

Terminal 91

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

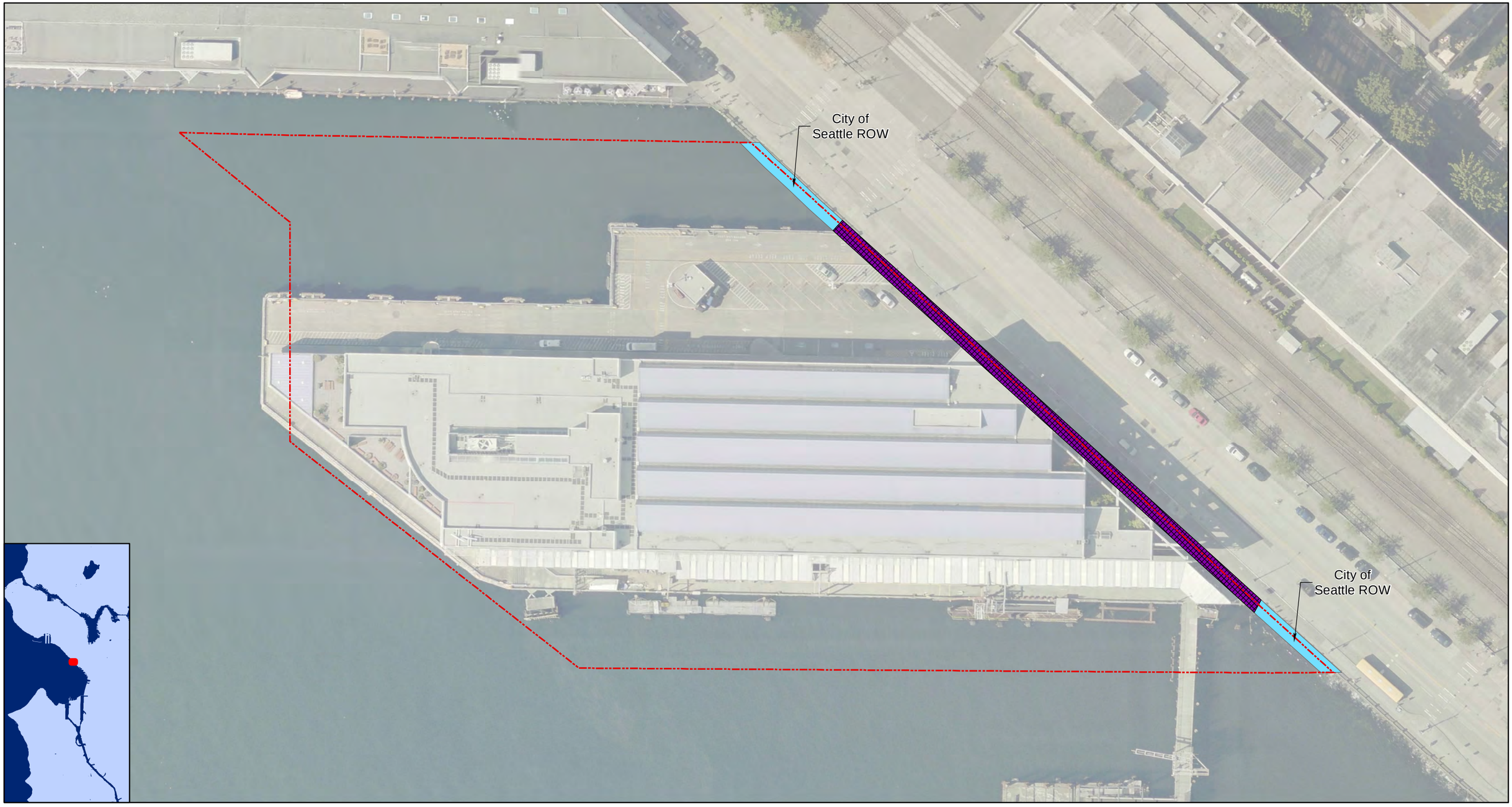
0 250 500 ft

Port-Owned Parcel Boundary

Primary Conditions
Conventional armored slope
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure
Riparian

Terminal 86 and Centennial Park



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 60 120
ft

Port-Owned Parcel Boundary

Primary Conditions

Vertical bulkhead

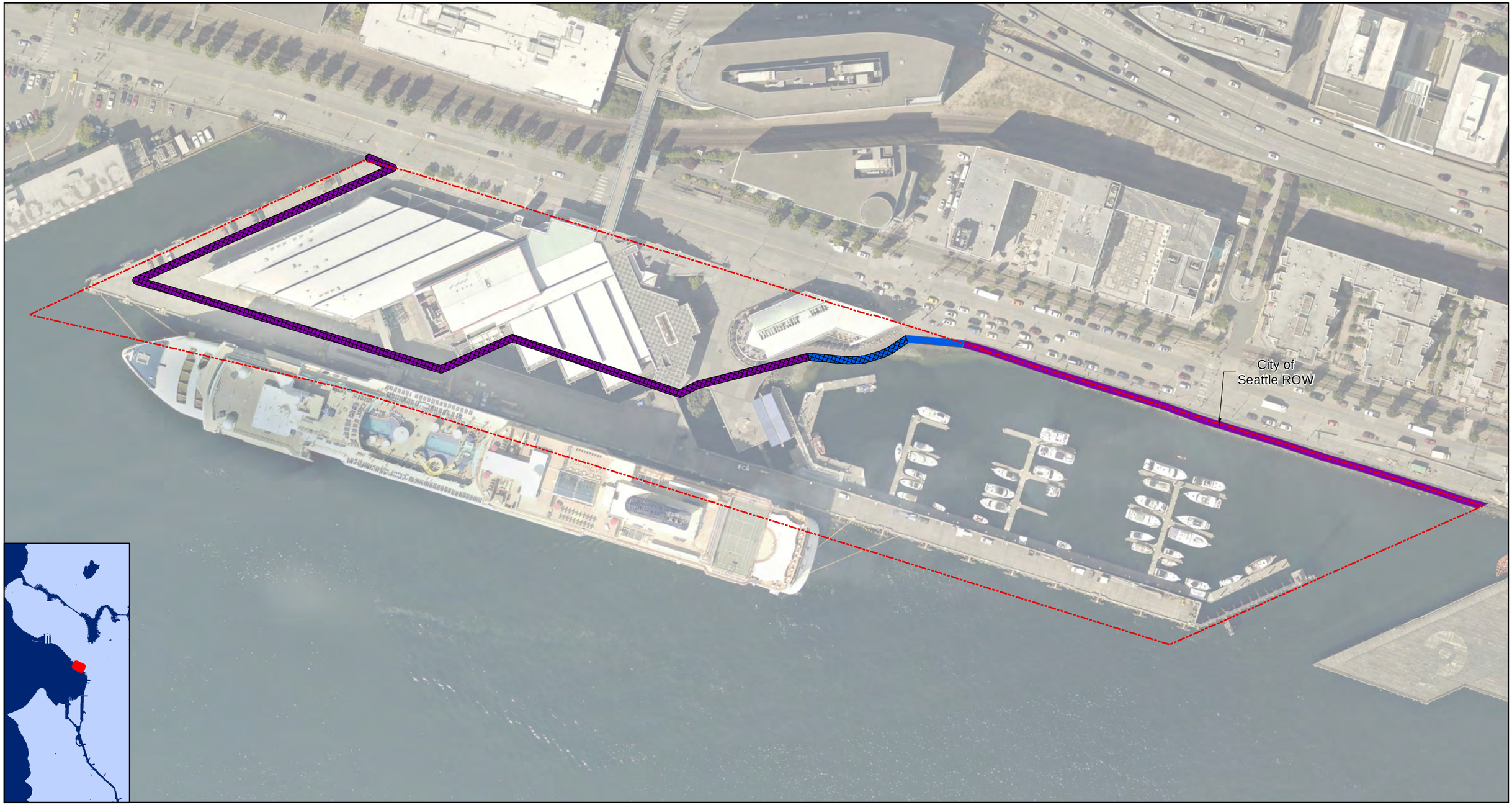
Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Pier 69

8



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 125 250
ft

Port-Owned Parcel Boundary
Primary Conditions
Conventional armored slope
Bulkhead and conventional armored slope
Secondary Conditions
Overwater structure

Pier 66

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 150 300 ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope

Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Terminal 46 - North

10

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 160 320 ft

Port-Owned Parcel Boundary

Primary Conditions
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure

Terminal 46 - South

11

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 130 260
ft

Port-Owned Parcel Boundary

Primary Conditions
- Vertical bulkhead
- Conventional armored slope
- Bulkhead and conventional armored slope

Secondary Conditions
- Overwater structure

Terminal 30 - North

12

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 140 280
ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope

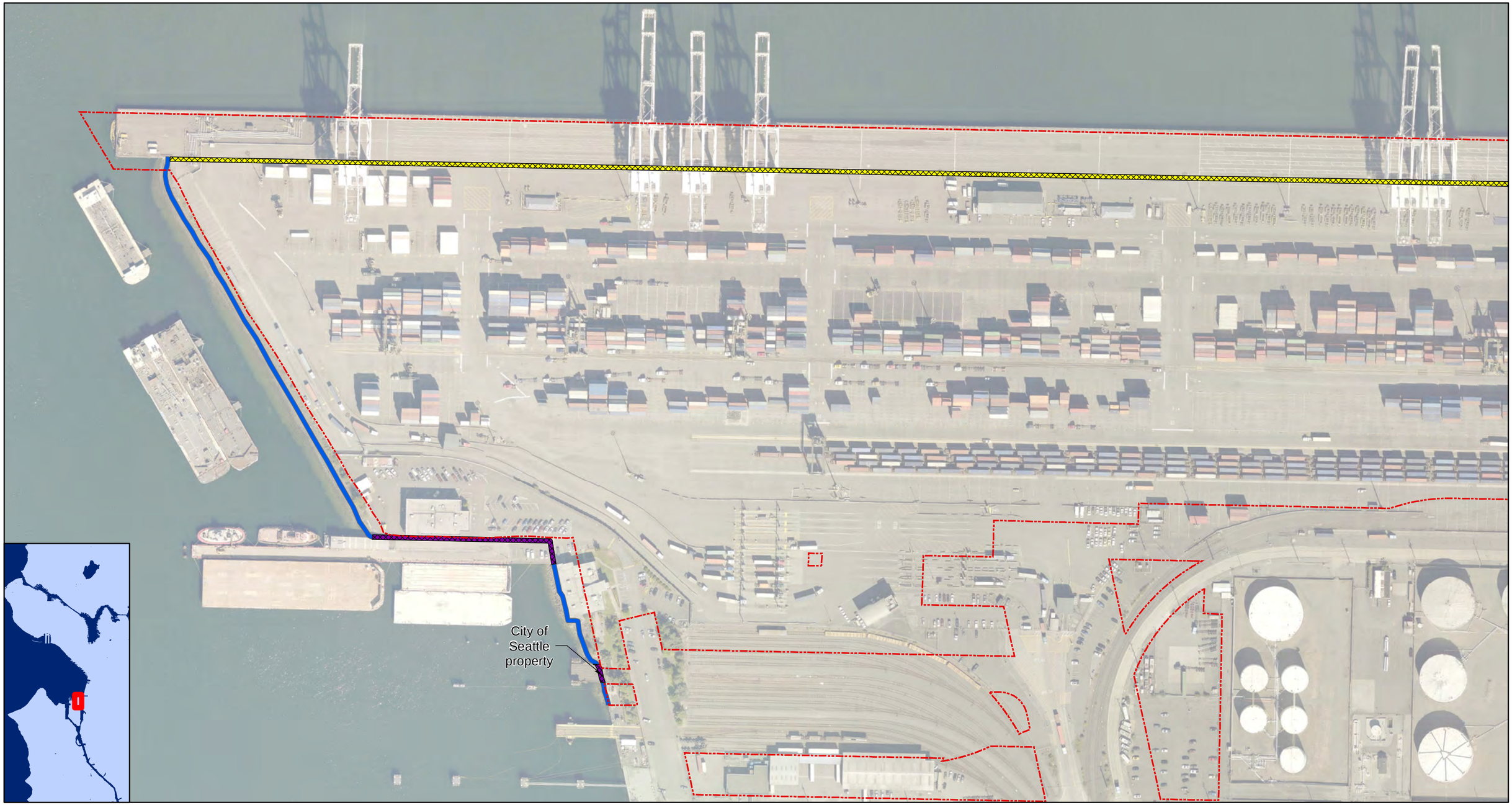
Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Terminal 30 - South

13



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 210 420 ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope and toe wall

Conventional armored slope

Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Terminal 18 - North

14

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 210 420 ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope and toe wall

Secondary Conditions

Overwater structure

Terminal 18 - South

15

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 175 350
ft

Port-Owned Parcel Boundary

Primary Conditions
Conventional armored slope
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure

Terminal 25

16

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

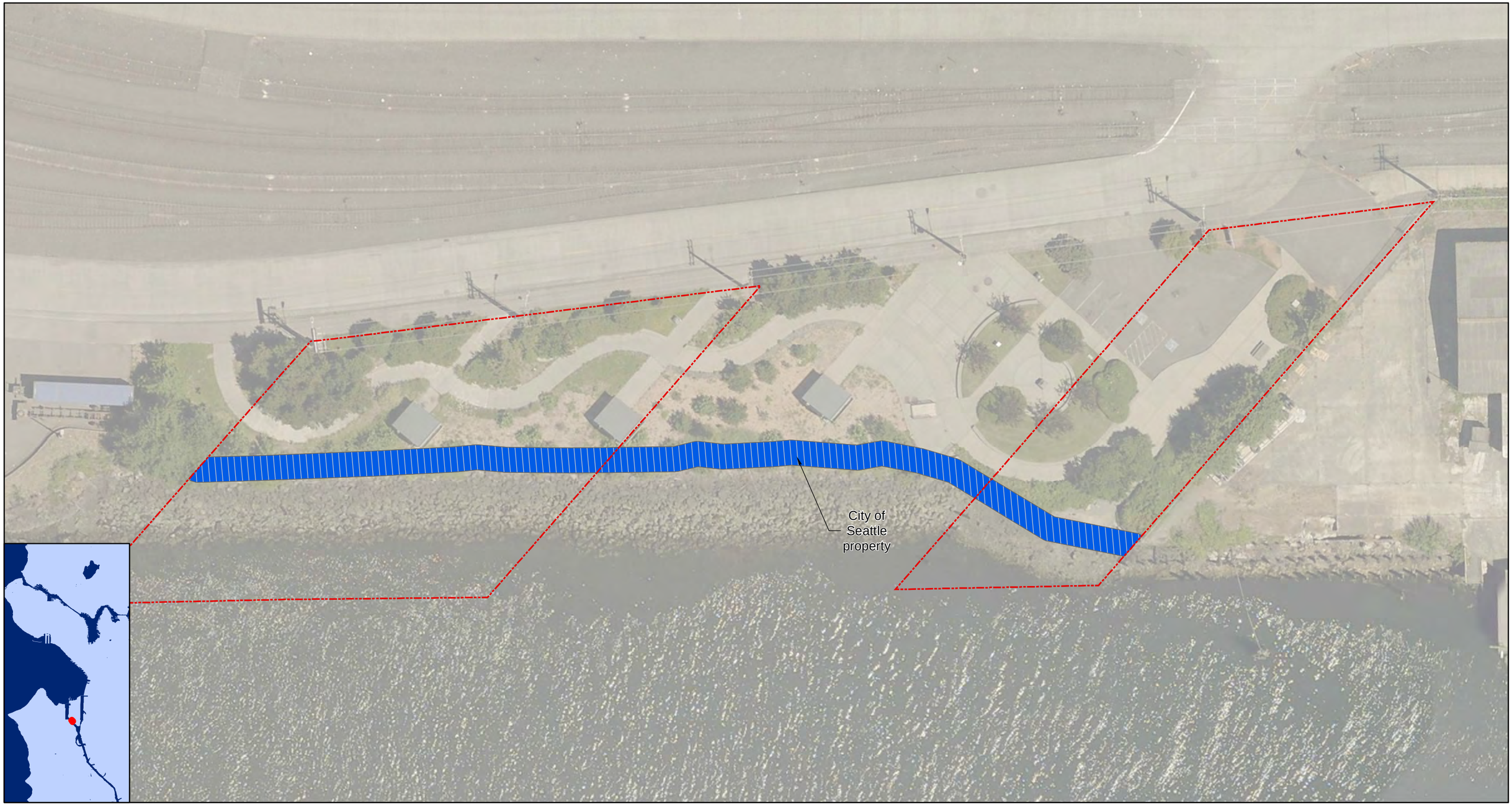
0 125 250 ft

Port-Owned Parcel Boundary

Primary Conditions
- Sloped bulkhead
- Natural beach
- Bulkhead and conventional armored slope
- Alternative stabilization

Secondary Conditions
- Riparian

Terminal 10



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 30 60
ft

Port-Owned Parcel Boundary
Primary Conditions
Conventional armored slope
Secondary Conditions
Riparian

Terminal 18 Public Access

18

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 150 300 ft

Port-Owned Parcel Boundary

Primary Conditions

- Vertical bulkhead
- Step wall bulkhead
- Rubble-strewn slope
- Conventional armored slope
- Bulkhead and conventional armored slope

Secondary Conditions

- Overwater structure

Terminal 5 - North

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 130 260
ft

Port-Owned Parcel Boundary

Primary Conditions
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure

Terminal 5 - South

20

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

Pier 2 and Jack Block Park

21

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 30 60 ft

Port-Owned Parcel Boundary

Primary Conditions

Step wall bulkhead

Conventional armored slope

Bulkhead and conventional armored slope

Secondary Conditions

Riparian

Terminal 5 SE

22

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 80 160 ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope

Secondary Conditions

Overwater structure

Riparian

Terminal 102

23

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

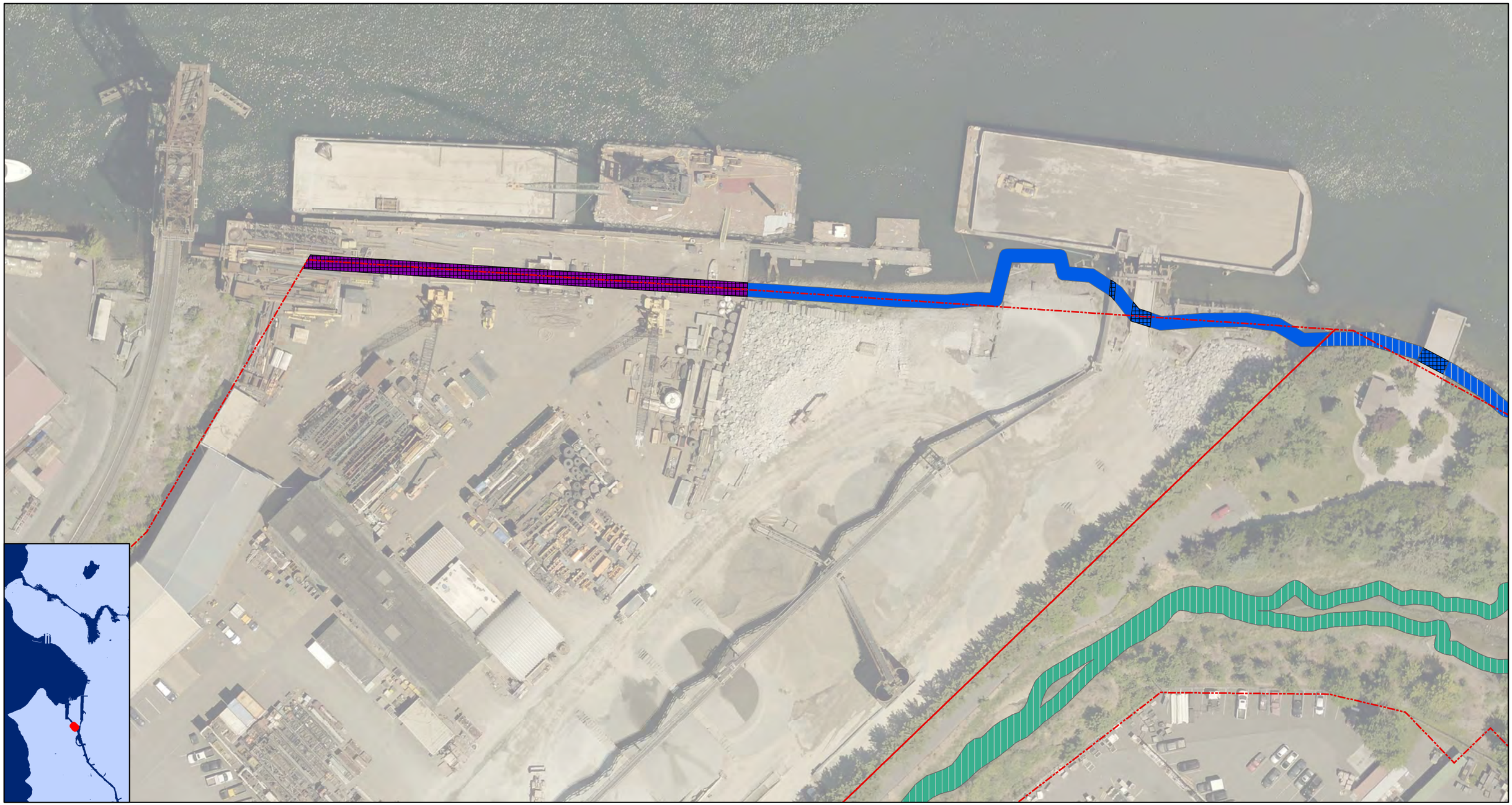
0 60 120
ft

Port-Owned Parcel Boundary

Primary Conditions
Conventional armored slope
Bulkhead and conventional armored slope

Secondary Conditions
Overwater structure
Riparian

Terminal 104



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 60 120 ft

Port-Owned Parcel Boundary

Primary Conditions
- Marsh
- Conventional armored slope
- Bulkhead and conventional armored slope

Secondary Conditions
- Overwater structure
- Riparian

Terminal 103

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 80 160 ft

Port-Owned Parcel Boundary

Primary Conditions
- Rubble-strewn slope
- Marsh
- Conventional armored slope
- Alternative stabilization

Secondary Conditions
- Overwater structure
- Riparian

Terminal 105

26

City of Seattle property

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 100 200 ft

Port-Owned Parcel Boundary

Primary Conditions

Conventional armored slope

Terminal 106

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 75 150 ft

Port-Owned Parcel Boundary

Primary Conditions
- Marsh
- Conventional armored slope
- Alternative stabilization

Secondary Conditions
- Riparian

Terminal 108

28

City of
Seattle ROW

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 160 320 ft

Port-Owned Parcel Boundary

Primary Conditions

- Rubble-strewn slope
- Natural beach
- Marsh
- Conventional armored slope

Secondary Conditions

- Riparian

Terminal 107 and Kellogg Island

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 110 220
ft

Port-Owned Parcel Boundary

Primary Conditions

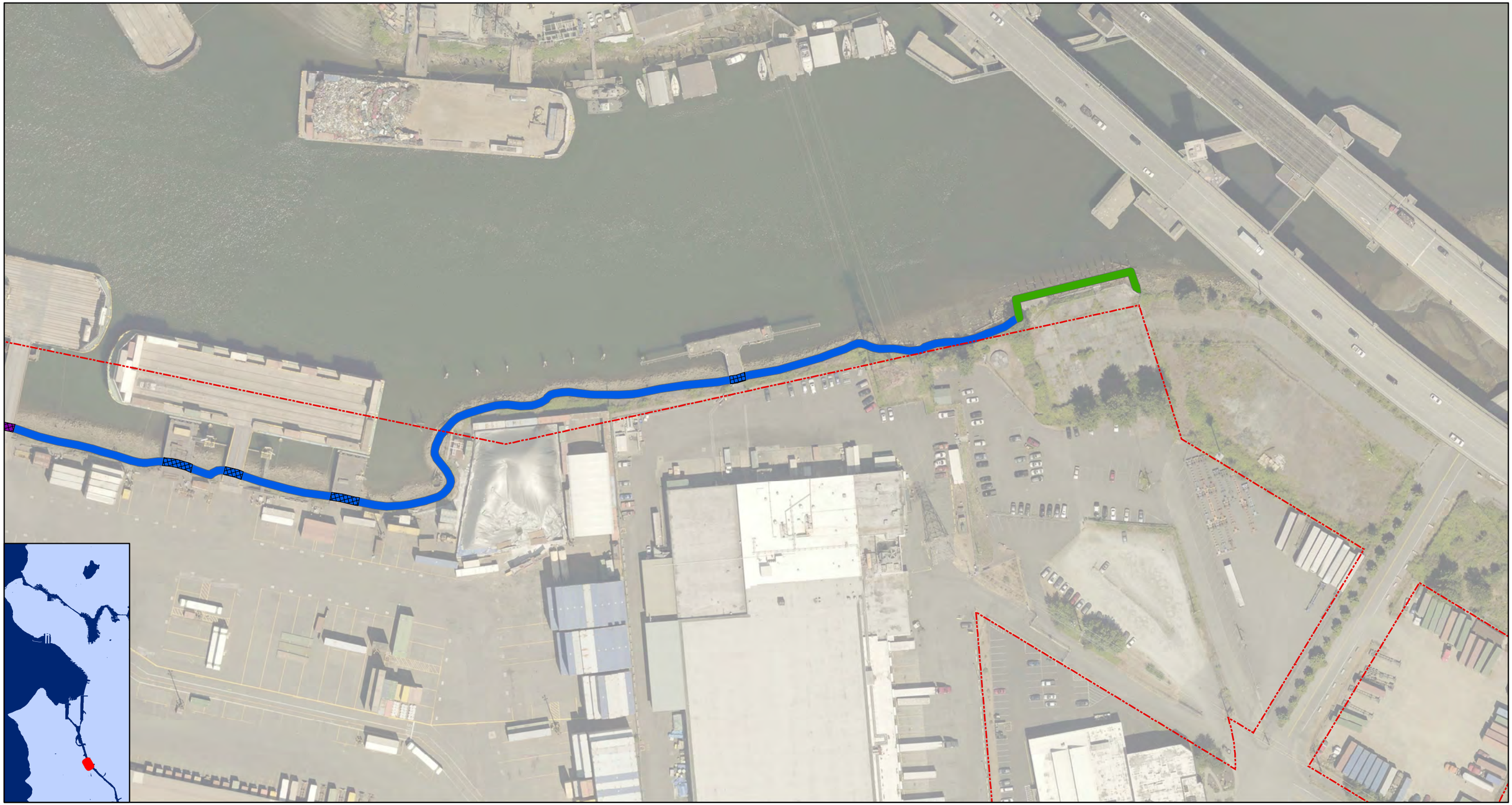
Conventional armored slope

Bulkhead and conventional armored slope

Secondary Conditions

Overwater structure

Terminal 115 - North



Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 110 220 ft

Port-Owned Parcel Boundary

Primary Conditions
- Step wall bulkhead
- Conventional armored slope
- Bulkhead and conventional armored slope

Secondary Conditions
- Overwater structure

Terminal 115 - South

31

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 60 120 ft

Port-Owned Parcel Boundary

Primary Conditions

Vertical bulkhead

Conventional armored slope

Terminal 117

32

Bankline Repair and Enhancement Multi-Site Program
Existing Bankline Characterization

0 80 160 ft

Port-Owned Parcel Boundary
Primary Conditions
Marsh
Secondary Conditions
Riparian

Turning Basin #3