Elliott Bay Seawall Project

Fish, Wildlife, and Vegetation Discipline Report

FINAL

October 2012

Submitted to:

City of Seattle
Department of Transportation
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Elliott Bay Seawall Project

FISH, WILDLIFE, AND VEGETATION DISCIPLINE REPORT

Agreement No. T09-24

FINAL

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This Discipline Report provides detailed background and analysis to support the City of Seattle's SEPA (Washington State Environmental Policy Act) Environmental Impact Statement for the Elliott Bay Seawall Project. This report also serves the same role to support the United States Army Corps of Engineers' NEPA (National Environmental Policy Act) environmental analysis for the Elliott Bay Seawall Project. Thus, both SEPA and NEPA references and considerations are included.

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Fish, Wildlife, and Vegetation Discipline Report

TABLE OF CONTENTS

Title **Page No.**

Executive Summary **ES-1**

CHAPTER 1. Project Description **1**

1.1 Project Background 1
1.2 Project Area Limits and Zones 2
1.3 Project Alternatives 3
1.4 No Action Alternative 3
1.5 Design Features Common to the Build Alternatives 4
1.5.1 Seawall 5
1.5.2 Habitat Improvements 5
1.5.3 Upland Improvements 6
1.6 Project Construction 7
1.6.1 Construction Schedule 7
1.6.2 Temporary Roadway and Construction Work Zone 7
1.6.3 Construction Methods 8
1.6.3.1 Soil Improvement 9
1.6.3.2 Braced Soldier Piles 9
1.6.4 Soil Dewatering and Spoils Disposal 9
1.6.5 Utility Protection and/or Relocation 10
1.7 Build Alternatives 11
1.7.1 Alternative A 11
1.7.1.1 Seawall 11
1.7.1.2 Roadway 11
1.7.1.3 Habitat Improvements 12
1.7.1.4 Upland Improvements 12
1.7.1.5 Construction and Schedule 12
1.7.2 Alternative B 15
1.7.2.1 Seawall 15
1.7.2.2 Roadway 15
1.7.2.3 Habitat Improvements 15
1.7.2.4 Upland Improvements 16
1.7.2.5 Construction and Schedule 16
1.7.3 Alternative C 19
1.7.3.1 Seawall 19
1.7.3.2 Roadway 19
1.7.3.3 Habitat Improvements 19
1.7.3.4 Upland Improvements 20
1.7.3.5 Construction and Schedule 20

CHAPTER 2. Methodology 35
2.1 Purpose of the Fish, Wildlife, and Vegetation Discipline Report 35
2.2 Discipline Study Overview 35
2.3 Evaluation Methodology 35

CHAPTER 3. Coordination and Information Sources 39
3.1 Document Review 39
3.2 Existing Environmental Documentation 39
3.2.1 Affected Environment 39
3.2.2 Species of Special Concern 40
3.3 Regulatory Framework: Federal, State, and Local Protection of Biological Resources 40
3.4 Surveys Conducted During This Study 42

CHAPTER 4. Affected Environment 43
4.1 Physical Environment 43
4.2 Historical Conditions 43
4.3 Current Conditions 43
4.3.1 Vegetation 44
4.3.1.1 Marine Vegetation 44
4.3.1.2 Upland Vegetation 47
4.3.2 Invertebrates 47
4.3.2.1 Pelagic Invertebrates 47
4.3.2.2 Benthic Invertebrates 49
4.3.2.3 Terrestrial Invertebrates 51
4.3.3 Fish 51
4.3.3.1 Resident Marine/Estuarine Fish 52
4.3.3.2 Anadromous Salmonids 54
4.3.4 Wildlife 58
4.3.4.1 Birds 58
4.3.4.2 Mammals 59
4.3.5 Climate Change 61
4.3.6 Pollutants in the Nearshore 61
4.3.7 Threatened, Endangered, and Candidate Species 63
4.3.7.1 Bocaccio; Puget Sound DPS 65
4.3.7.2 Southern Resident Killer Whale 65
4.3.7.3 Pacific Eulachon; Southern DPS 66
4.3.7.4 Bull Trout; Coastal-Puget Sound DPS 67
4.3.7.5 Chinook Salmon; Puget Sound ESU 68
4.3.7.6 Steelhead; Puget Sound DPS 69
4.3.7.7 Canary Rockfish; Puget Sound DPS 70
4.3.7.8 Yelloweye Rockfish; Puget Sound DPS 71
4.3.7.9 Marbled Murrelet 72
4.3.7.10 Steller Sea Lion; Eastern DPS 72
4.3.7.11 Coho Salmon; Puget Sound/Georgia Basin ESU 73
4.3.7.12 Chum Salmon; Puget Sound/Strait of Georgia ESU 74
4.3.8 Essential Fish Habitat 75
4.3.8.1 Essential Fish Habitat in the Study Area 76
4.3.8.2 Habitat Areas of Particular Concern in the Study Area 77

CHAPTER 5. Construction Effects and Mitigation 79
5.1 No Action Alternative 79
5.2 Underwater Construction Noise 80
5.3 Alternative A 84
5.3.1 Installation and Removal of Temporary Containment Wall 85
5.3.2 Seawall Pullback and Construction 86
5.3.3 Upland Construction 88
5.3.4 Habitat Enhancement Related Construction 89
5.3.5 Other Construction Improvements 90
5.3.6 Construction Summary of Effects 91
5.4 Alternative B 91
5.4.1 Installation and Removal of Temporary Containment Wall 91
5.4.2 Seawall Pullback and Construction 93
5.4.3 Upland Construction 94
5.4.4 Habitat Enhancement Related Construction 95
5.4.5 Other Construction Improvements 96
5.4.6 Construction Summary of Effects 96
5.5 Alternative C 96
5.5.1 Installation and Removal of Temporary Containment Wall 97
5.5.2 Seawall Pullback and Construction 99
5.5.3 Upland Construction 100
5.5.4 Habitat Enhancement Related Construction 101
5.5.5 Other Construction Improvements 102
5.5.6 Construction Summary of Effects 102
5.6 Mitigation Measures and Best Management Practices 102

CHAPTER 6. Operational Effects and Mitigation 105
6.1 No Action Alternative 106
6.2 Alternative A 107
6.2.1 Benefits of Habitat Enhancement 108
6.2.2 Adverse Effects of Habitat Enhancement 110
6.2.3 Other Operational Effects 111
6.2.4 Operational Effects Summary 111
6.3 Alternative B 112
6.3.1 Benefits of Habitat Enhancement 112
6.3.2 Adverse Effects of Habitat Enhancement 114
6.3.1 Other Operational Effects 115
6.3.2 Operational Effects Summary 116
6.4 Alternative C 116
6.4.1 Benefits of Habitat Enhancement 117
6.4.2 Adverse Effects of Habitat Enhancement 119
6.4.3 Other Operational Effects 120
6.4.4 Operational Effects Summary 120
6.5 Indirect Effects 120
6.6 Mitigation Measures 121

CHAPTER 7. References 123

Appendix A. Species Lists

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LIST OF TABLES

No.	Title	Page No.
Table 1-1.	Comparison of Features of the Three Elliott Bay Seawall Project Build Alternatives	23
Table 4-1.	Approximate Salmonid Seasonal Timing in the Waters of Elliott Bay, Including the Study Area	55
Table 4-2.	Endangered, Threatened, and Candidate Species Present in and Around the Elliott Bay Seawall Project Area	64
Table 5-1.	Unattenuated Noise Levels for Different Types of Pilings Proposed for the Elliott Bay Seawall Project	80
Table 5-2.	Current Noise Thresholds for Fish and Wildlife Taxa	81
Table 6-1.	Summary of Habitat Enhancements by Zone for Alternatives A, B, and C	105

LIST OF FIGURES

No.	Title	Page No.
Figure 1-1.	Elliott Bay Seawall Project Area	1
Figure 1-2.	Elliott Bay Seawall Zone Designations	2
Figure 1-3.	Conceptual Rendering of Proposed Habitat Improvements	6
Figure 1-4.	Construction Work Zone and Temporary Roadway	8
Figure 1-5.	Representative Cross Section Showing Typical Existing Utility Locations within Project Limits	10
Figure 1-6.	Alternative A, Stage 1	13
Figure 1-7.	Alternative A, Stage 2	13
Figure 1-8.	Alternative A, Stage 3	14
Figure 1-9.	Alternative A, Stage 4	14
Figure 1-10.	Alternative B, Stage 1	17
Figure 1-11.	Alternative B, Stage 2	17
Figure 1-12.	Alternative B, Stage 3	18
Figure 1-13.	Alternative B, Stage 4	18
Figure 1-14.	Alternative C, Stage 1	21
Figure 1-15.	Alternative C, Stage 2	21
Figure 1-16.	Alternative C, Stage 3	22
Figure 1-17.	Alternative C, Stage 4	22
Figure 1-18.	Alternative A: Central Seawall Plan	27
Figure 1-19.	Alternative A: North Seawall Plan	28
Figure 1-20.	Alternative B: Central Seawall Plan, Option 1	29
Figure 1-21.	Alternative B: Central Seawall Plan, Option 2	30
Figure 1-22.	Alternative B: North Seawall Plan	31
Figure 1-23.	Alternative C: Central Seawall Plan	32
Figure 1-24.	Alternative C: North Seawall Plan	33
Figure 2-1.	Typical Cross Section of the Elliott Bay Seawall Project Area Showing Important Physical Biological Features	37
Figure 4-1.	Algae Found in the Study Area	46
Figure 4-2.	Upland Vegetation Found in the Study Area	48
Figure 4-3.	Benthic Invertebrates Found in the Study Area	50
Figure 4-4.	Fishes Found in the Study Area;	53
Figure 5-1.	Maximum Distances at which Species would be Affected by Impact and Vibratory Pile Driving	83

ACRONYMS, ABBREVIATIONS AND DEFINITIONS

AWV	Alaskan Way Viaduct
BMP	Best Management Practice
BNSF	BNSF Railways
BSP	braced soldier pile
City	City of Seattle
CSO	combined sewer overflow
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
ESU	Evolutionarily Significant Unit
EBSP	Elliott Bay Seawall Project
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
LPS	light-penetrating surface(s)
HAPC	Habitat Areas of Particular Concern
HCP	WDFW Habitat Conservation Plan
HPA	WDFW Hydraulic Project Approval
MHHW	mean higher high water
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyl
PHS	Priority Habitat and Species; WDFW
ppt	parts per trillion
SDOT	Seattle Department of Transportation
SEPA	State Environmental Policy Act
SF	square feet
SPCC	Spill Prevention, Containment, and Control Plan
USFWS	United States Fish and Wildlife Service
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

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EXECUTIVE SUMMARY

This Fish, Wildlife, and Vegetation Discipline Report evaluates the alternatives under consideration for replacing the Elliott Bay Seawall. This report and the Elliott Bay Seawall Project (EBSP) Draft Environmental Impact Statement that it supports are intended to assess the potential environmental impacts associated with the EBSP. The Fish, Wildlife, and Vegetation Discipline Report presents the detailed technical analysis of existing conditions and predicted effects of each build alternative and the No Action Alternative.

The EBSP would rebuild the existing Elliott Bay Seawall in order to reduce the risks of coastal storm and seismic damages, and to protect public safety, critical infrastructure, and associated economic activities along Seattle's central waterfront. Additionally, the project would improve the degraded ecosystem functions and processes of the Elliott Bay nearshore in the vicinity of the existing seawall. The primary goals of the ecosystem restoration measures proposed are to (1) provide a functional migratory corridor for juvenile salmonids and (2) improve ecosystem productivity.

This Discipline Report addresses the No Action Alternative and the build alternatives, which include the following:

- Alternative A provides a basic structural solution and habitat improvements, with minimum wall setback distances, a soil improvement seawall structure, an improved habitat migration corridor, and enhanced aquatic substrates.
- Alternative B utilizes a braced soldier pile (BSP) seawall structure, coupled with more ambitious habitat and public-amenity creation. These habitat and public amenity features are achieved with significant wall pull-back distances, wider habitat bench areas, and enhanced aquatic substrates.
- Alternative C is a true hybrid alternative, representing features from both Alternatives A and B. The construction methods described for Alternative A (i.e., soil improvement) also applies to Alternative C. The scope of habitat and public-amenity features will be intermediate relative to the other build alternatives.

The EBSP build alternatives contain several typical elements of construction that would impact biological resources. These typical elements of construction include upland excavation and wall pull-back areas; new wall construction techniques; offshore habitat improvements; outfall reconstruction and use of in-water construction equipment; and demolition of existing structures and relocation of utilities. Effects from construction include disturbance from construction activities, redistribution of contaminated sediments in the nearshore, and some mortality of sessile wildlife due directly to construction activities.

Adverse effects from construction would likely be short term and moderate for all build alternatives and would only be present in areas of active construction. Alternative B is expected to have more adverse construction environmental effects than Alternative A due to its larger footprint and longer construction duration; effects from Alternative C are expected to be intermediate relative to the other build alternatives. Mitigation measures and Best Management Practices (BMPs) are proposed that would be used to avoid and minimize adverse impacts that could occur. Short-term and moderate construction effects are anticipated under the No Action Alternative due to emergency construction that

may be required to fix wall failures. If a substantial failure of the wall were to occur, substantial construction effects could result due to the need to provide immediate emergency repairs to contain upland soils, stabilize infrastructure, and reconnect piers.

Operational impacts for all build alternatives are expected to be generally beneficial and long term for the environment in the study area. The nearshore would gain improved ambient lighting, a migration corridor for salmonids, improved substrate for marine algae and invertebrate attachment, and native upland plantings that would provide habitat primarily for salmonid prey species such as terrestrial insects. Some adverse effects, however, are also expected and could potentially include increased exposure of fish and wildlife from human disturbance and contaminants and from periodic post-construction maintenance. Operational effects are mostly long term and would last throughout the life of the constructed features. Alternative B would be expected to provide a larger beneficial effect on the nearshore environment than Alternative A due to its larger footprint and scope. Alternative C would provide a similar but slightly lesser benefit than Alternative B. Mitigation measures and BMPs would be used to minimize any adverse impacts that could occur. Effects resulting from seawall failure are anticipated under the No Action Alternative.

After comparison of the build alternatives, some differences in construction and operational effects of EBSP Alternatives A, B, and C have been identified. Alternative A includes moving the seawall landward 10 to 15 feet from its existing location except for in Zone 3 where it would be moved waterward of the existing seawall by three feet and in Zone 1 where it will be reconstructed in place. These changes would allow for habitat improvements to occur in the proposed project area and incorporate features that would improve nearshore and upland habitat. Alternative B, in contrast, includes moving the seawall landward up to 75 feet and providing a larger net increase in aquatic habitat area, thus allowing for more habitat features to be placed in the proposed project area. The proposed features of Alternative B would provide increased quantity and quality of habitat compared to those in Alternatives A or C. Alternative C only differs from Alternatives A and B in that the seawall would be moved from its existing location 10 to 15 feet landward in all locations. Alternative A likely would incur less effects to the nearshore than Alternative B or C because of its smaller footprint; however, adverse effects from any of the build alternatives would likely be relatively minor and short term in nature. There likely would not be any difference in operational effects from the two types of structural wall options (soil improvement or BSP) as both would be buried behind the wall face.

Mitigation measures have been proposed to avoid and minimize the environmental impacts associated with the typical elements of construction used in the EBSP build alternatives. The mitigation measures include only performing in-water work during the approved in-water work window (August 1 to February 15) or approved extension to the in-water work window, minimizing construction disturbance in upland and nearshore areas, and using BMPs for all aspects of upland and in-water work (such as the temporary containment wall and silt curtains). The in-water work window and any possible extensions will be further refined in coordination with regulatory agencies.

Under any of the build alternatives, construction work under the EBSP would comply with any permit conditions from local, state, and federal agencies to ensure the proper protection of biological resources in the area. The cumulative effect of this proposed action in conjunction with other area construction

projects should provide an overall improvement of biological resources throughout the Seattle waterfront.

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CHAPTER 1. PROJECT DESCRIPTION

1.1 PROJECT BACKGROUND

The City of Seattle Department of Transportation (SDOT) is proposing to construct the Elliott Bay Seawall Project (EBSP), which will replace the existing seawall along the shoreline of downtown Seattle. Extending from S. Washington Street to Broad Street, the seawall supports and protects the adjacent upland areas, which contain residences, commercial businesses and restaurants, parks and public facilities, transportation infrastructure (including sidewalks, streets, and a rail line), and a large number of utilities (Figure 1-1). The harbor area in Elliott Bay is used by ferries, cruise ships, and commercial vessels, as well as for recreation. Overall, the waterfront is an important center of commerce and recreation for the entire city and region.

Figure 1-1. Elliott Bay Seawall Project Area

The existing seawall includes three types of structures, all constructed between 1911 and 1936 and ranging in size from approximately 15 to 60 feet wide. Over time, these structures have deteriorated as a result of various natural and physical processes. The seawall's poor condition makes it vulnerable to significant damage during a major storm or seismic event. Therefore, the EBSP is a critical public safety project. The completed seawall will provide protection from coastal storm damages, seismic damages, and shoreline erosion, and will thereby contribute to the preservation of Seattle's downtown, the local economy, and the region's economic competitiveness and quality of life. Seawall replacement will also provide the foundation and structural support for the downtown Seattle waterfront, including improvements planned as part of Waterfront Seattle.

The project's purpose is to reduce the risks of coastal storm and seismic damages and to protect public safety, critical infrastructure, and associated economic activities along Seattle's central waterfront. Additionally, the project will improve the degraded ecosystem functions and processes of the Elliott Bay nearshore in the vicinity of the existing seawall.

Construction of a new seawall would have both beneficial and adverse effects on environmental resources. This discipline report will examine the effects of the project on fish, wildlife, and vegetation as part of the project's overall environmental documentation.

1.2 PROJECT AREA LIMITS AND ZONES

The project area for the EBSP extends from S. Washington Street to Broad Street, from the eastern edge of pavement below State Route (SR) 99 to the waters of Elliott Bay. The project has been divided into six zones. Zones 1 through 4 constitute the Central Seawall Study Area. The two remaining zones, Zones 5 and 6, make up the North Seawall Study Area. A delineation of the zones is provided in Figure 1-2 and concept plans are included at the end of this chapter.

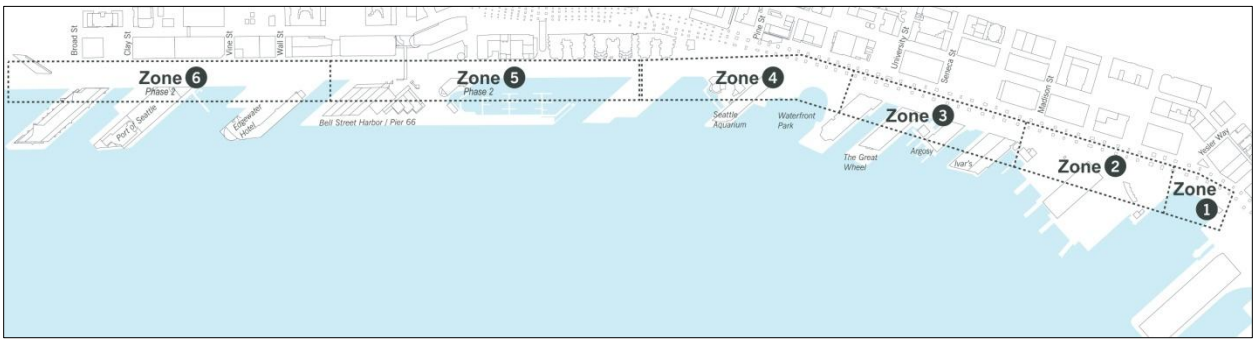


Figure 1-2. Elliott Bay Seawall Zone Designations

Central Seawall Study Area (S. Washington Street to Virginia Street):

- Zone 1, the Pioneer Square/Washington Street Boat Landing Zone, runs from S. Washington Street to Yesler Way.
- Zone 2, the Ferry Terminal Zone, stretches from Yesler Way to Madison Street, and includes the Colman Dock ferry terminal and Fire Station No. 5.
- Zone 3, the Central Pier Zone, includes the historic waterfront piers (Piers 54 to 57) and runs from Madison Street to just north of University Street.
- Zone 4, the Park/Aquarium Zone, includes Waterfront Park, the Seattle Aquarium, and Piers 62/63. This zone runs from north of University Street to approximately Virginia Street.

North Seawall Study Area (Virginia Street to Broad Street):

- Zone 5, the Bell Harbor Zone, runs from Virginia Street to Battery Street. This zone includes the Bell Harbor Conference Center, Cruise Ship Terminal, and Marina.
- Zone 6, the North Pier Zone, stretches from Battery Street to Broad Street, and includes the Edgewater Hotel, Port of Seattle Offices, and Pier 70.

1.3 PROJECT ALTERNATIVES

The EBSP Environmental Impact Statement (EIS) evaluates a No Action Alternative and three build alternatives for the project. As required by the National Environmental Policy Act (NEPA) and the Washington State Environmental Policy Act (SEPA), the build alternatives represent different ways of accomplishing the project purpose. Evaluating alternatives allows SDOT decision-makers, with input from the public, agencies, and tribes, to consider environmental impacts in conjunction with other decision factors such as cost, schedule, and feasibility.

The build alternatives for the EBSP are:

- **Alternative A**, which would reconstruct the seawall as close to its existing alignment as possible. Jet grouting, a subsurface soil improvement, would be used to form the seawall's structural support. Habitat improvements would include the addition of shoreline enhancements, installation of a continuous habitat bench, and intermittent light-penetrating surfaces (LPS) at piers.
- **Alternative B**, which would move the seawall up to 75 feet landward of its current location. Braced soldier piles (BSP) would be used to build an underground wall structure. Moving the seawall inland would allow the construction of expanded habitat enhancements and mostly continuous LPS, in addition to the habitat improvements and continuous habitat bench described for Alternative A.
- **Alternative C**, which would move the seawall up to 15 feet landward of its current location. This alternative would use subsurface soil improvements (likely including both jet grouting and deep soil mixing) to provide structural support. Alternative C would provide a continuous habitat bench and continuous LPS, in addition to shoreline enhancements similar to Alternative B.

These three build alternatives encompass a range of design ideas to establish "bookends" for the project, thus capturing a suite of potential options, impacts, and effects. Features of the alternatives could be blended in future design phases to reflect public, agency, and stakeholder input.

The following section (Section 1.4) describes the No Action Alternative. Section 1.5 discusses the features that are common to the three build alternatives and Section 1.6 provides an overview of project construction. Section 1.7 provides additional detail on specific features that differ among the build alternatives.

1.4 NO ACTION ALTERNATIVE

NEPA, SEPA, and the City of Seattle's (City's) implementing regulations (Seattle Municipal Code [SMC] 25.05) require that a No Action Alternative is evaluated in addition to the build alternatives in the EIS. The No Action Alterative provides a baseline against which the potential effects of the build alternatives can be compared.

The No Action Alternative is projected over the next 50 years. Given the age and condition of the seawall, continued deterioration and some level of failure will likely occur within the 50-year timeframe. Because the existing seawall is vulnerable to various types of damage, the No Action Alternative must

anticipate the possibility of degrees of seawall failure. Therefore, three No Action scenarios have been evaluated:

1. Minimal Damage: This scenario would not require a significant repair of the seawall, and any needed repairs could be undertaken by the City. Small failures caused by tidal erosion (as are currently happening today) or minor seismic events would result in settlement of the wall or collapse of the roadway or sidewalk on Alaskan Way. This scenario assumes continued operation of the seawall with ongoing maintenance as needed.
2. Loss of Functionality: This scenario would result from sustained damage, and the seawall would no longer be considered safe for public access and could no longer perform the majority of its essential functions. As with the Minimal Damage scenario, this scenario could result from either tidal or seismic events.
3. Collapse of the Seawall: This scenario would occur only as a result of seismic damage; however, collapse resulting from a seismic event could trigger additional damage from tidal erosion. Seawall failure would have significant impacts on the public, Seattle, the Puget Sound region, Washington State, and the nation. Loss of the seawall's function would disrupt or destroy the critical transportation infrastructure that runs along the Seattle waterfront, potentially displacing hundreds of thousands of vehicles on roadways, 30,000 daily ferry passengers who use Colman Dock ferry terminal, and 24 freight trains and six passenger trains that run near the waterfront. It would also jeopardize critical utility corridors that serve downtown Seattle and the region, and would impair the viability of the waterfront as a major tourist destination and regional economic engine.

Conditions without the project were defined as part of a separate Elliott Bay Seawall Feasibility Study, conducted by the United States Army Corps of Engineers (USACE). The "without project" conditions serve a similar purpose in the feasibility study as does the No Action Alternative under SEPA. The without project conditions are summarized below to provide additional detail about the No Action scenarios.

- The City would continue to repair minimal damage failures unless three or more sections of the seawall fail in a single year, at which point the seawall is assumed to have lost its functionality.
- The City would stabilize the shoreline following seawall collapse to minimize erosion impacts. This stabilization would help to prevent the permanent loss of landward structures, utilities, and the Burlington Northern Santa Fe (BNSF) rail line to erosion.
- If functionality of the seawall were lost, the City would construct a trestle bridge to maintain access to Colman Dock Ferry Terminal and Fire Station No. 5.
- If functionality of the seawall were lost, the City would repair or relocate affected utilities.

1.5 DESIGN FEATURES COMMON TO THE BUILD ALTERNATIVES

If implemented, the EBSP would replace the failing seawall that runs along Elliott Bay and underneath Alaskan Way and would restore and enhance aquatic habitat along the seawall's new face. A new

seawall would reduce the risk of seismic damage and protect Seattle's downtown waterfront from wind-driven storm waves and erosive tidal forces; safeguard major public and private utilities, including power for downtown Seattle and the region, natural gas, and telecommunications; support SR 99, Colman Dock ferry terminal, and rail lines; and enhance habitat for juvenile salmon and other marine life. Additionally, the project would be compatible with future improvements currently being planned at and near the waterfront.

All build alternatives encompass three major categories of design features: the new seawall itself, improvements to aquatic habitat, and improvements to upland areas. Each of these categories is described briefly below.

1.5.1 Seawall

The primary function of the new seawall is to provide protection from storm and wave erosion, impacts from floating objects, and resistance from lateral pressures such as those caused by an earthquake. A new seawall face would generally be placed either close to or somewhat landward of its current position. Depending on the build alternative selected, the final location of the seawall face would vary from approximately 3 feet waterward to 75 feet landward of the existing alignment. It would be most efficient to leave the existing seawall in place during construction of the new seawall and to build the new structure either behind or in front of the existing face.

The new seawall would also reduce the risks related to seismic activity. How these risks are reduced would differ between the alternatives. Soil improvement in the form of jet grouting with or without deep soil mixing (Alternatives A and C) would minimize the risk of liquefaction by physically stabilizing liquefiable soils behind the seawall, while the BSP method (Alternative B) would not prevent liquefaction but rather would resist the lateral spreading and migration of soil that results from liquefaction. Both methods would stabilize the seawall during seismic events. The design life of the new seawall is 75 years.

1.5.2 Habitat Improvements

Rebuilding the seawall would provide the opportunity to improve adjacent aquatic habitat. Habitat improvement measures would be implemented as part of each build alternative. These measures would be designed to restore a functional intertidal migration corridor along the seawall for juvenile salmonids, and would also improve ecosystem productivity to enhance the marine nearshore food web. Figure 1-3 shows a conceptual rendering of the proposed habitat improvements.

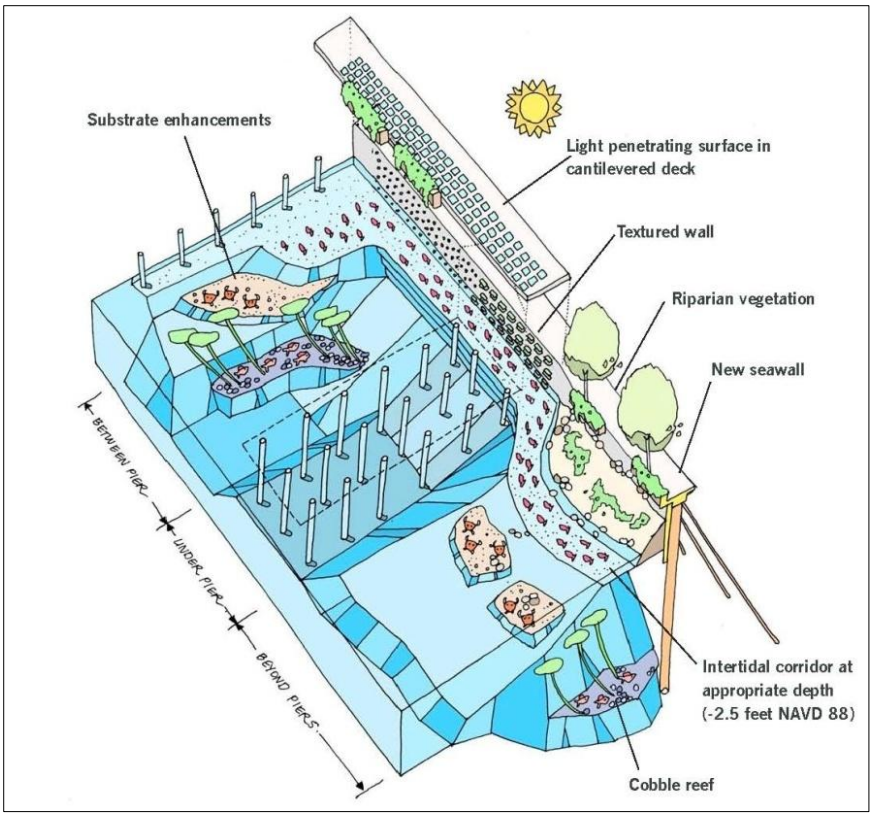


Figure 1-3. Conceptual Rendering of Proposed Habitat Improvements

The intertidal migration corridor for juvenile salmonids would be improved by:

- Modifying substrate depths to create a habitat bench and achieve appropriate intertidal and shallow-water habitat elevations;
- Improving the diversity of off-shore substrate by supplementing it with coarse substrate;
- Increasing textures on the seawall face to encourage the development of marine nearshore habitat and attachment of aquatic organisms;
- Adding riparian plants along the wall and sidewalk to provide food (insects and detritus) for migrating salmon; and
- Increasing daylight illumination of the habitat bench and other nearshore habitat by including LPS in a cantilevered or pile-supported sidewalk.

Enhanced ecosystem productivity would generally be accomplished by:

- Enhancing substrate by supplementing it with cobble, pea gravel, and shell hash; and
- Constructing the textured wall face, riparian plantings, LPS, and suitable bench substrate.

1.5.3 Upland Improvements

In addition to replacing the seawall and restoring aquatic habitat, the three build alternatives would provide a number of upland improvements. The existing Alaskan Way roadway, multi-use trail, and parking would be restored to their original function and capacity after construction. The restored

sidewalk along the waterfront would range from 15 to 30 feet in width and include a cantilevered portion with LPS that would benefit the marine habitat below. Viewing areas would be provided waterward of the sidewalk and would offer opportunities for public gathering space. New railings, formal and informal seating, bicycle racks, wayfinding elements, and other design amenities would also be included as project improvements. All build alternatives would restore the historic Washington Street Boat Landing, either maintaining its current location or moving it 15 feet waterward.

Currently, there are no water quality facilities for treating surface water runoff from Alaskan Way. Stormwater drainage pipes in the project area would be reconstructed and stormwater quality would be improved through the installation of treatment to meet code by removing the bulk of suspended solids, oils, and greases. These actions would improve water quality in the nearshore of the project area. It would be expected that new stormwater structures would initially require less maintenance than those currently in place and, as a result, have fewer detrimental impacts on the environment. As the project design moves forward, other stormwater management strategies could be identified that provide greater environmental benefit without increasing environmental impacts.

1.6 PROJECT CONSTRUCTION

1.6.1 Construction Schedule

Central Seawall construction is expected to begin in fall of 2013 and would progress from north to south, beginning in Zone 4 and ending in Zone 1. Based on current schedules, Central Seawall construction would last three to five construction seasons depending on the alternative, with construction seasons extending from approximately Labor Day to Memorial Day to avoid major disruption during the peak tourist season. The North Seawall would be built as a separate construction phase and would require an additional four construction seasons.

1.6.2 Temporary Roadway and Construction Work Zone

To accommodate construction activities during replacement of the seawall, the existing Alaskan Way roadway would be relocated beneath the Alaskan Way Viaduct. Three lanes of traffic would be maintained underneath the viaduct throughout construction. The resulting space along the waterfront would be used as a work zone during construction of the Central Seawall (Figure 1-4). During North Seawall construction, this dedicated construction work zone would not be available, and the temporary roadway would be accommodated in the available right-of-way.

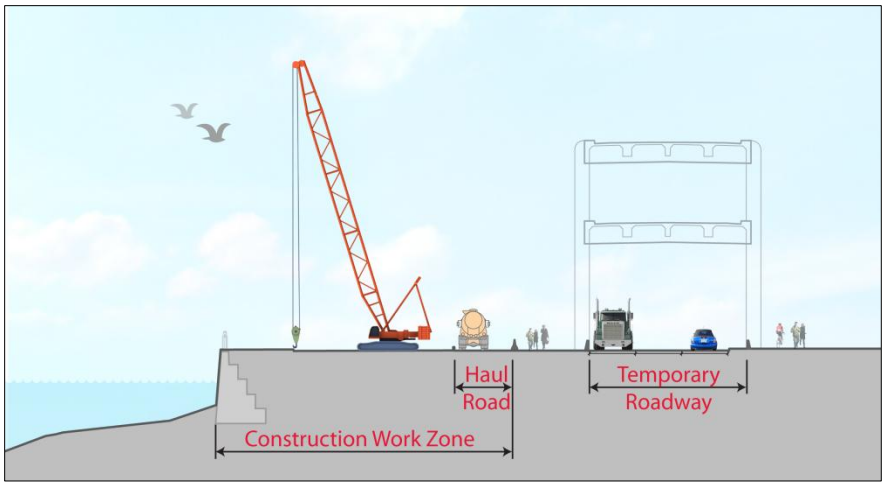


Figure 1-4. Construction Work Zone and Temporary Roadway

The construction work zone would extend from the western edge of the existing multi-use path on Alaskan Way to the water. Existing street trees would be removed to provide additional space within this area and would either be replaced as riparian plantings with the EBSP or replaced during future waterfront improvement projects. The existing streetcar tracks that run along Alaskan Way would also be removed during construction.

Construction would be staged from several locations within the work zone. Staging areas would vary in size and would be used for delivery and storage of construction materials and equipment. The staging areas would be sited to avoid disrupting access to piers, residences, and businesses along the waterfront. In addition to the upland staging areas, construction activities may also be staged from barges and tugs in Elliott Bay.

During Central Seawall construction, some temporary parking spaces could be provided as part of each construction stage. During the first stage of construction, parking could be provided on the existing Alaskan Way roadway south of the active work zone. During the later stages when construction has progressed to the southern portion of the project area, parking could be provided on the restored roadway to the north of active construction. During North Seawall construction, a similar program of temporary parking would be implemented, to the extent possible.

To the greatest extent possible, construction materials and personnel would be transported to the construction work zone and staging areas via freeways and arterials. However, other city streets could provide access to the site when needed. The eastern border of the construction work zone along Alaskan Way would serve as a haul road to channel truck traffic within the project area.

The existing multi-use trail would be maintained (with the potential for temporary detours), and access to the piers would be maintained throughout construction.

1.6.3 Construction Methods

The seawall would be replaced using soil improvement, BSP, or a combination of these two methods. A brief description of each method is provided below.

1.6.3.1 Soil Improvement

Soil improvement is a general term for a variety of techniques that are used to stabilize existing soils by improving their internal structure and strength. Two techniques that are being considered for the EBSP are jet grouting and deep soil mixing. Jet grouting consists of adding grout to existing soils to form a "block" of improved soil mass that extends down to the competent foundation below. This technique has been identified as a feasible way to strengthen the material underlying the project area, which includes an existing timber relieving platform, buried timber piles, utilities, and other potential obstructions.

Jet grouting creates circular columns of soil cement by means of a hollow drill pipe measuring a few inches in diameter that is inserted into the soil. Grout is then sprayed into the surrounding soil under high pressure through horizontal nozzles in the rotating drill pipe. This process cuts the existing soil and mixes the soil with the grout. The strength of the soil would be substantially improved through this process, thus greatly reducing the soil's potential for liquefaction during an earthquake.

The grout columns would be constructed in a grid pattern to create a block of improved soil. The grid pattern would be installed between the timber piles of the existing seawall to eliminate the need to remove the existing piles. The finished arrangement of the grouted columns would create a "spine" for the new seawall. The grouting process generates spoils that would be disposed of using appropriate means, in accordance with applicable regulations.

Deep soil mixing, another technique that could be used for soil improvement, uses an auger that penetrates the ground surface to mix and consolidate the underlying soils to a depth of up to 20 feet. With deep soil mixing, no grout is applied under pressure and there are minimal spoils for disposal.

1.6.3.2 Braced Soldier Piles

BSP is an alternative structural stabilization method. This method would involve drilling large holes (approximately 8 feet in diameter) to a depth of approximately 75 feet below the present street level of Alaskan Way where the firm layer of glacial till is located. An oscillator, a specialized piece of drilling equipment, would install a steel casing as the drilling progresses to prevent the holes from collapsing and to contain the soils to be excavated. The leading edge of the casing would be equipped with cutting teeth to carve through the timber boards and piles of the existing relieving platform and into the soils below.

Once the holes have been drilled and excavated to the final depth, a steel reinforcing cage would be placed into the shaft casing and the casing would be filled with concrete. The casing would be extracted as the concrete is poured and would leave behind a reinforced concrete cylinder, or soldier pile. A line of these soldier piles would be constructed to form the spine of the seawall. Soil anchors would then be installed to brace or tie back these soldier piles.

1.6.4 Soil Dewatering and Spoils Disposal

Regardless of the construction method that is selected, excavations into soils in the construction zone would need to be dewatered, which generally involves disposing of the wastewater offsite or pumping

the excess water to a location where it can be settled and/or before discharge. Wet spoils from jet grouting or other soil improvement activities must be managed or disposed of as well. SDOT is currently exploring various methods for managing and disposing wastewater and jet grout spoils, which would be detailed in the project's dewatering and erosion control submittals required as part of the Clean Water Act Section 401 and National Pollutant Discharge Elimination System (NPDES) construction general stormwater permit processes, as well as by the City's standard construction specifications.

1.6.5 Utility Protection and/or Relocation

The project area contains a large number of utilities, including water, sanitary sewer, combined sewer, stormwater, electrical transmission and distribution, steam, gas, fire alarm, and numerous telecommunication systems. These utilities range from major transmission lines serving portions of Seattle and the region to individual connections serving adjacent properties. As shown in Figure 1-5, some of these utilities are directly beneath the Alaskan Way roadway and sidewalk and above the relieving platform of the existing seawall, while others extend through the seawall to the piers.

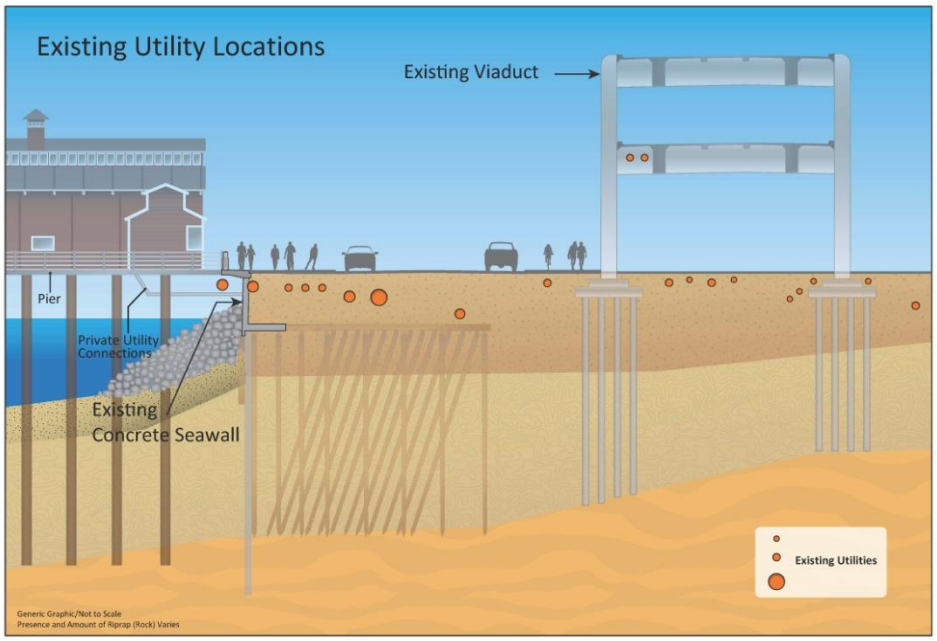


Figure 1-5. Representative Cross Section Showing Typical Existing Utility Locations within Project Limits

SDOT's objective will be to maintain utility service to the greatest extent possible during construction, although the means and methods for doing so would vary depending on the construction method used. Alternatives A and B assume that all soil overlying the relieving platform would need to be excavated. Excavation would require temporary or permanent relocation of the majority of existing utilities. Alternative C assumes that most soil improvement could be accomplished through small penetrations at street level, which would allow the majority of the utility lines above the relieving platform to remain in place during that construction activity. With either method, most individual service lines would be temporarily relocated and reinstalled in their final locations as seawall construction progresses. Final points of service to the waterfront piers would remain the same to alleviate the need to update the

facilities to the current Uniform Building Code. The final construction method chosen will not preclude the ability of utilities to provide future new services to the downtown waterfront area.

1.7 BUILD ALTERNATIVES

The preceding sections provided information on project elements that would be similar among the three build alternatives. The following discussion focuses on the primary differences among Alternatives A, B, and C in terms of the seawall's location, the configuration of Alaskan Way, habitat improvements, public amenities, and construction sequence and schedule. Table 1-1 (at the end of this chapter) compares key features of the alternatives.

1.7.1 Alternative A

Alternative A would reconstruct the seawall as close to its existing alignment as possible, with jet grouting forming the structural support. Habitat improvements would include the addition of shoreline enhancements and the installation of a continuous habitat bench and LPS at piers. Figures 1-18 and 1-19 at the end of this chapter depict Alternative A.

1.7.1.1 Seawall

In Alternative A, the new seawall would be reconstructed as close to the alignment of the existing seawall as possible, with only a minimal setback (as outlined in the bulleted list below). This placement would allow construction to proceed without requiring the removal of the existing wall first.

The approximate proposed location of the seawall face for Alternative A relative to the existing seawall face would be:

- Zone 1 – in place (no change),
- Zone 2 – 15 feet landward,
- Zone 3 – 3 feet waterward, and
- Zones 4, 5, and 6 – 10 feet landward.

In Zone 1, the seawall would be reconstructed in its existing location to minimize potential conflicts with construction of the SR 99 bored tunnel, which is being built as part of a separate project. In Zones 2, 4, 5, and 6, the new wall would be constructed behind (east of) the existing wall, and then the existing seawall west of the new seawall face would be demolished. In Zone 3, the new seawall structure would be constructed to the west of the existing wall, resulting in the new seawall face being set three feet waterward of its current location.

1.7.1.2 Roadway

The existing Alaskan Way is generally four lanes (two lanes in each direction), except in the vicinity of Colman Dock (Yesler Way to Spring Street), where it consists of one northbound lane and two southbound lanes. Alternative A would add a permanent northbound lane between S. Washington and

Madison Streets[1] to handle traffic in this segment headed to Colman Dock and through to other destinations. A temporary second northbound lane (constructed by the Washington State Department of Transportation [WSDOT]) is currently in place. Parking and loading zones in the finished configuration would be similar to today.

A sidewalk of approximately the same width as the existing sidewalk (15 to 20 feet) would be provided on the west side of the street. The sidewalk would be cantilevered or pile supported in Zones 2 through 6 and would extend back to the piers in all zones, with LPS provided where feasible. The mixed-use trail on the east side of Alaskan Way would be extended from its existing terminus north to Clay Street. At Clay Street, the trail would cross Alaskan Way and continue on the west side of Alaskan Way to Broad Street, where it would connect to the existing trail system that runs along Olympic Sculpture Park and Myrtle Edwards Park.

1.7.1.3 Habitat Improvements

Alternative A would provide an effective intertidal corridor along the seawall to support juvenile salmonid migration and would enhance ecosystem productivity. Habitat benches, a sidewalk with LPS, a textured wall face, subtidal substrate enhancements, cobble reefs, and riparian plants would be installed. No net loss of ecological function or intertidal elevation would occur.

1.7.1.4 Upland Improvements

Under Alternative A, public amenities would include the restored historic Washington Street Boat Landing, improved water-viewing opportunities at various locations, new or replaced railings, new sidewalks, waterfront planters, and street plantings. Reconstructed sidewalks would extend from the curb line of the restored Alaskan Way to the western edge of the existing sidewalk. These improvements would add variety to the waterfront by defining gathering spaces, viewing areas, and building entries.

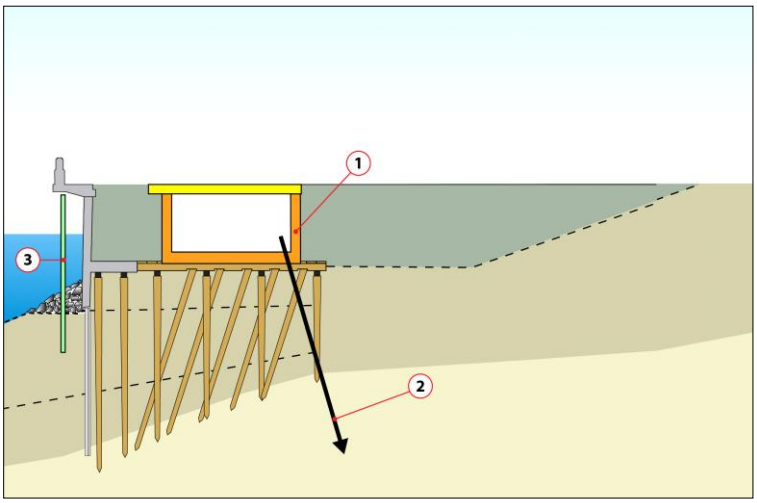
1.7.1.5 Construction and Schedule

Under Alternative A, the construction method proposed for the primary structural element of the seawall is soil improvement. With this method, construction of the Central Seawall would require approximately three construction seasons with two summer shutdown periods. Construction of the North Seawall would require an additional four construction seasons with three summer shutdown periods. The current plan for Alternative A is to begin construction of the Central Seawall in Zone 4, move southward to Zone 3, and then progress to Zones 2 and 1. The Central Seawall construction would be followed by the North Seawall construction in Zones 6 and 5.

The anticipated construction activities and probable sequence for Alternative A, using jet grouting for the soil improvement, are depicted in Figures 1-6 through 1-9. The figures describe four primary stages of work that would occur along the waterfront. The construction activities within each zone would vary

[1] The Elliott Bay Seawall Project would build the additional lane from S. Washington Street to Madison Street. The portion between S. King Street and S. Washington Street would be constructed as part of the Alaskan Way Viaduct Replacement Project.

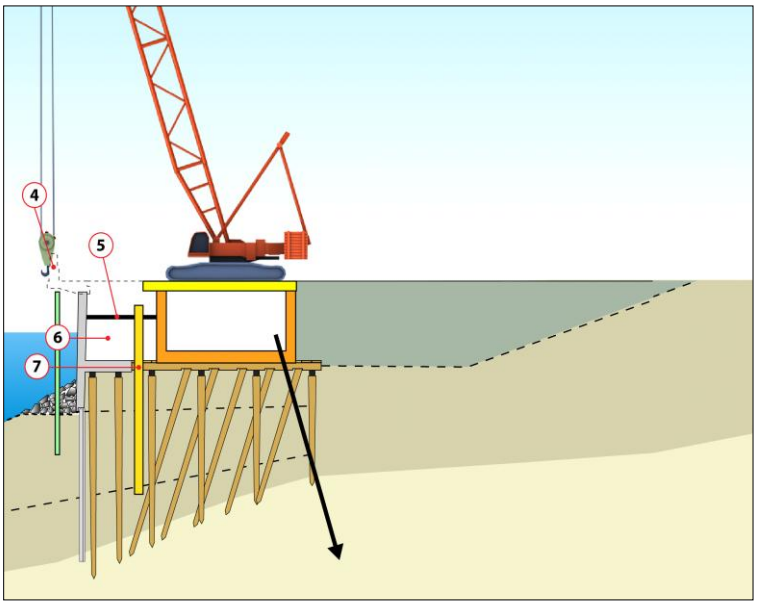
depending on the type of existing seawall. The figures depict the Type A seawall. (Type A seawall is a sheet-pile supported, reinforced, concrete face panel, which is tied back to a buried timber relieving platform supported by vertical and battered timber piles.) For Alternative A, it was assumed that the area above the existing relieving platform would be excavated before jet grouting begins.



Alternative A, Stage 1

1. Excavate to the top of relieving platform, relocate utilities, and install shoring
2. Install soil anchors
3. Remove existing riprap and install temporary containment wall

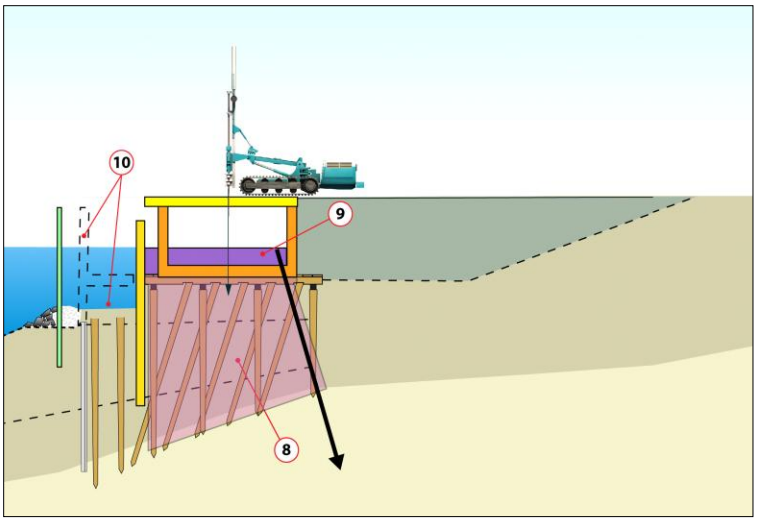
Figure 1-6. Alternative A, Stage 1



Alternative A, Stage 2

4. Remove existing cantilever sidewalk
5. Brace existing concrete face panel
6. Excavate remaining soil
7. Install concrete face panel

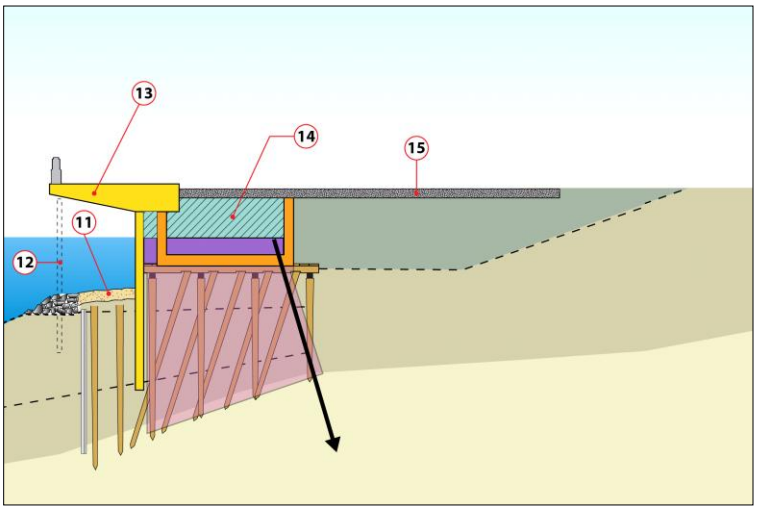
Figure 1-7. Alternative A, Stage 2



Alternative A, Stage 3

8. Install soil improvement (jet grouting)
9. Install anchor slab
10. Remove portion of existing wall

Figure 1-8. Alternative A, Stage 3



Alternative A, Stage 4

11. Place substrate
12. Remove temporary containment wall
13. Install sidewalk
14. Restore utilities and backfill
15. Complete restored roadway

Figure 1-9. Alternative A, Stage 4

1.7.2 Alternative B

Alternative B would move the seawall up to 75 feet landward of its current location, with BSP forming an underground wall structure to protect against coastal storm damage and seismic forces. In addition to the habitat improvements described for Alternative A, this alternative would construct a continuous habitat bench and continuous LPS at the piers. Figures 1-20, 1-21, and 1-22 at the end of this chapter depict Alternative B.

1.7.2.1 Seawall

Under Alternative B, the new seawall would be constructed up to 75 feet east of the existing seawall alignment and would provide a range of potential design opportunities. The approximate proposed location of the seawall face for Alternative B, relative to the existing seawall face, would be:

- Zone 1 – 0 to 15 feet landward,
- Zone 2 – 15 feet landward,
- Zone 3 – 30 feet landward,
- Zone 4 – 30 to 75 feet landward following the restored road curb alignment, and
- Zones 5 and 6 – 10 feet landward.

In Zones 1, 2, 5, and 6, the new wall would be constructed 10 to 15 feet east of the existing wall. In Zones 3 and 4, the new wall would be constructed 30 to 75 feet farther east, allowing greater flexibility for future habitat and public amenity spaces. This eastward realignment would largely reshape the downtown Seattle waterfront. After the new seawall was in place, the existing seawall would be demolished.

1.7.2.2 Roadway

Under Alternative B, the lane configuration of Alaskan Way would remain identical to the current configuration because of the confined space that would be available between the location of the seawall (eastward of the existing seawall) and the existing Alaskan Way Viaduct structure. A temporary northbound lane between Yesler Way and Spring Street has been installed by WSDOT, and it may be used during seawall construction.

Similar to the other build alternatives, the existing roadway, sidewalk, and multi-use trail would be restored to their original function and capacity after construction, with the multi-use trail connecting to the existing trail system that runs along Olympic Sculpture Park and Myrtle Edwards Park. However, due to space constraints, southbound parking and loading in Zone 3 may be restricted between University and Madison Streets.

1.7.2.3 Habitat Improvements

Alternative B would include the installation of habitat benches, a sidewalk with LPS, a textured wall face, subtidal substrate enhancements, cobble reefs, and riparian plants. However, the intertidal habitat

would be larger because the seawall would be set back farther east (landward). Alternative B would provide substantial enhancements within the new aquatic land available in Zones 1, 3, and 4.

Zone 1 would include an intertidal habitat bench and backshore that would be bordered by riparian plants, rocks, and drift logs. In Zone 3, the 30-foot seawall setback would allow the installation of a confined-substrate habitat bench with LPS installed above. In Zone 4, the 75-foot seawall setback would allow expanded upland riparian planting or increased intertidal habitat.

1.7.2.4 Upland Improvements

Alternative B would improve water viewing at various locations and provide additional public gathering spaces, as well as interpretive, recreational, and cultural opportunities. The new sidewalks would be enhanced with LPS and reconfigured with planters and new or replaced railings along the length of the seawall. These additional and enhanced gathering and overlook spaces would be provided in Zones 1, 3, 4, 5, and 6.

In Zone 1, Washington Street Boat Landing would be restored and reinstalled within the Washington Street right-of-way, west of its current location to improve its connection to the water. A new gangway and short-stay boat moorage could be created to restore the landing's historic connection with Elliott Bay. North of the boat landing, steps and a boardwalk (Option 1) or boulders (Option 2) could be added for seating and for physical access to or viewing of the new intertidal habitat bench.

Zones 3, 5, and 6 would include viewpoints between the piers. These viewpoints would create opportunities for public gathering, seating, and water viewing. The viewpoints would be parallel with the adjacent piers, thereby directing the view out to Elliott Bay. The viewpoints would include seating steps and stairs to bring people closer to the water.

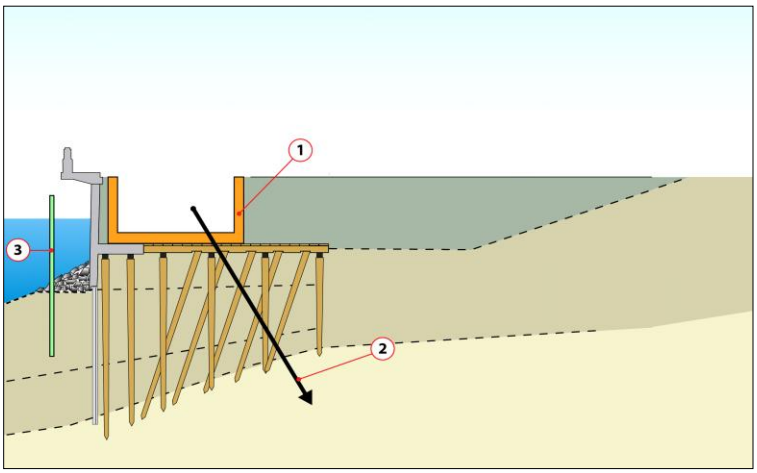
In Zone 4, the proposed seawall setback of 30 to 75 feet would provide two types of opportunities: a water plaza (Option 1) or a land plaza (Option 2). In Option 1, openings in the expansive plaza and walk would allow users to view tide pools and aquatic life below. In Option 2, raised planters would be filled with riparian plants, logs, and stones that would be reminiscent of Puget Sound shorelines.

1.7.2.5 Construction and Schedule

Under Alternative B, the design option proposed for the primary structural element of the seawall is BSP installed by means of a drilled-shaft construction method. With this method, construction of the Central Seawall would require approximately five construction seasons with four summer shutdown periods. Construction of the North Seawall would require an additional four construction seasons, similar to Alternatives A and C, although the duration may be slightly longer.

Access during construction would be more difficult than for either Alternatives A or C because the eastward setback of the seawall would restrict the construction staging areas to the project ends (i.e., north and south extents), instead of alongside the construction work zone. Under Alternative B, it would not be possible to maintain a continuous construction haul road because of the seawall setback in Zones 3 and 4. The construction of a land plaza or water plaza in Zone 4 would increase the duration of construction.

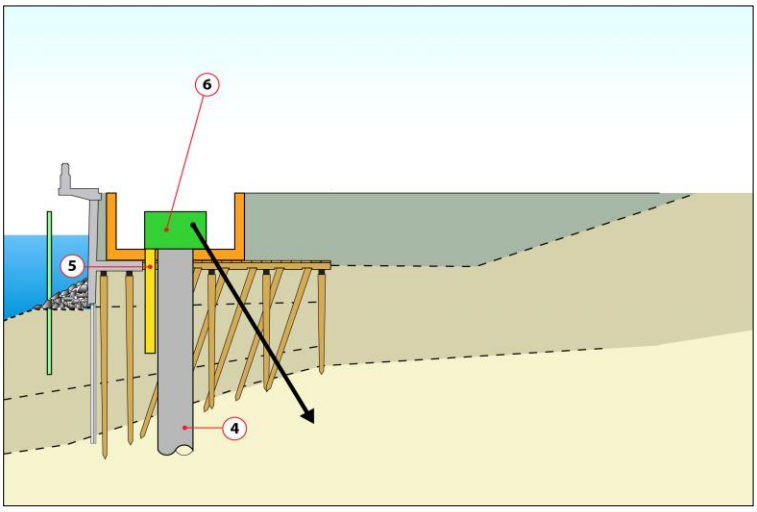
Construction of the Central Seawall would begin in Zone 4, move southward to Zone 3, and then progress to Zones 2 and 1. The Central Seawall construction would be followed by the North Seawall construction in Zones 6 and 5. The anticipated construction stages for Alternative B (assuming a Type A existing seawall) are shown in Figures 1-10 through 1-13.



Alternative B, Stage 1

1. Excavate to top of relieving platform, relocate utilities, and install shoring
2. Install soil anchors
3. Remove existing riprap and install temporary containment wall

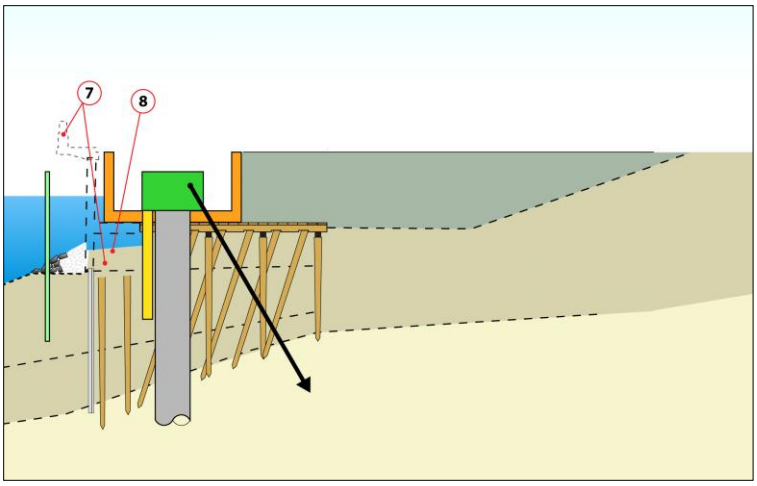
Figure 1-10. Alternative B, Stage 1



Alternative B, Stage 2

4. Drill shaft
5. Install concrete face panel
6. Cast concrete anchor cap

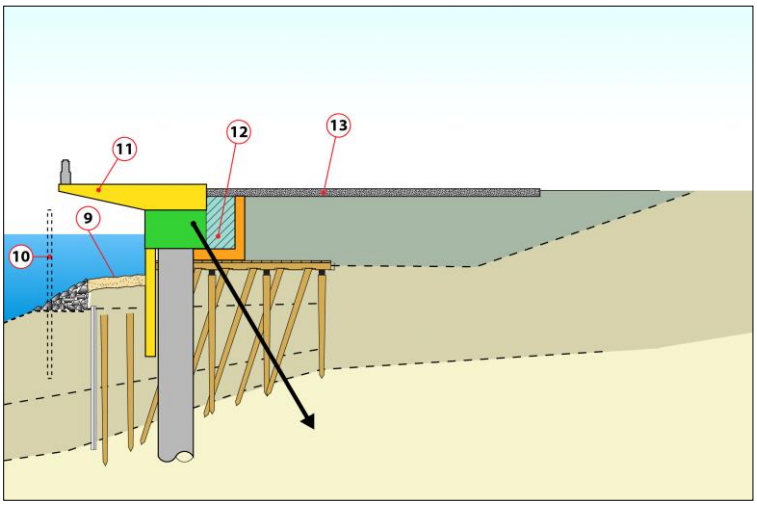
Figure 1-11. Alternative B, Stage 2



Alternative B, Stage 3

7. Remove existing cantilever sidewalk
8. Remove portion of existing wall

Figure 1-12. Alternative B, Stage 3



Alternative B, Stage 4

9. Place substrate
10. Remove temporary containment wall
11. Install sidewalk
12. Restore utilities and backfill
13. Complete restored roadway

Figure 1-13. Alternative B, Stage 4

1.7.3 Alternative C

Alternative C would move the seawall up to 15 feet landward of its current location and would use soil improvements (likely including both jet grouting and deep soil mixing) to provide structural support. Alternative C would also provide a continuous habitat bench and continuous LPS in addition to shoreline enhancements. Figures 1-23 and 1-24 at the end of this chapter depict Alternative C.

1.7.3.1 Seawall

Under Alternative C, the seawall would be constructed approximately 10 to 15 feet landward of the existing seawall alignment along its entire length. The setback proposed for Alternative C would allow soil improvements to proceed without first removing the existing seawall. The approximate proposed location of the seawall face for Alternative C relative to the existing seawall face would be:

- Zones 1 and 2 – 15 feet landward,
- Zone 3 – 10 to 15 feet landward, and
- Zones 4, 5, and 6 – 10 feet landward.

1.7.3.2 Roadway

The existing roadway is generally four lanes (two lanes in each direction), except in the vicinity of Colman Dock (Yesler Way to Spring Street), where it consists of one northbound lane and two southbound lanes. Alternative C would add a permanent northbound lane between S. Washington and Madison Streets[2] to support traffic bound for Colman Dock and other destinations. A temporary second northbound lane (constructed by WSDOT) is currently in place and could be used during seawall construction. Parking and loading zones would be similar to those present today.

A sidewalk of approximately the same width as the existing sidewalk (15 to 20 feet) would be provided on the west side of the street after construction. The sidewalk alignment would be cantilevered or pile supported and would extend back to the piers in all zones. The mixed-use trail on the east side of Alaskan Way would be extended north from its existing terminus to Clay Street, where it would cross Alaskan Way and continue on the west side of the street to Olympic Sculpture Park and Myrtle Edwards Park.

1.7.3.3 Habitat Improvements

Like Alternatives A and B, Alternative C would include a number of habitat improvements. These improvements would extend 10 to 45 feet from the face of the new seawall. An intertidal bench would be installed at the base of the seawall to form a shallow angle to the seafloor and provide shallower water for juvenile salmon migration. Installation of a textured seawall face panel would support the development of marine nearshore habitat. Restoration of riparian areas along the back beach area in Zone 1 would include species of riparian and beach shrubs native to Puget Sound.

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[2] The Elliott Bay Seawall Project would build the additional lane from S. Washington Street to Madison Street. The portion between S. King Street and S. Washington Street would be constructed as part of the Alaskan Way Viaduct Replacement Project.

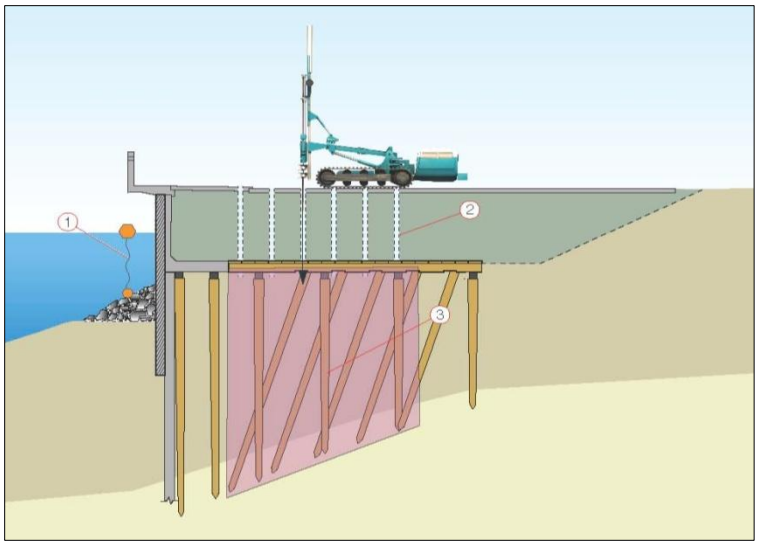
1.7.3.4 Upland Improvements

Under Alternative C, the restored sidewalk space would be enhanced with LPS and include new or upgraded railings, historic elements, wayfinding features, and lighting. Water-viewing opportunities would be preserved or enhanced at various locations, and additional viewing opportunities would be included at Spring and University Streets in Zone 3. In Zone 1, the Washington Street Boat Landing would be restored and reinstalled within the S. Washington Street right-of-way.

1.7.3.5 Construction and Schedule

For Alternative C, the construction method proposed for the primary structural element of the seawall is soil improvement. Alternative C assumes that the soil improvement would be accomplished from street level, without excavating the soils over the relieving platform. After seawall stabilization, the area above the relieving platform would be excavated to allow for installation of the new seawall face and sidewalk. With this method, construction of the Central Seawall would require approximately three construction seasons with two summer shutdown periods. Subsequent construction of the North Seawall would require an additional four construction seasons.

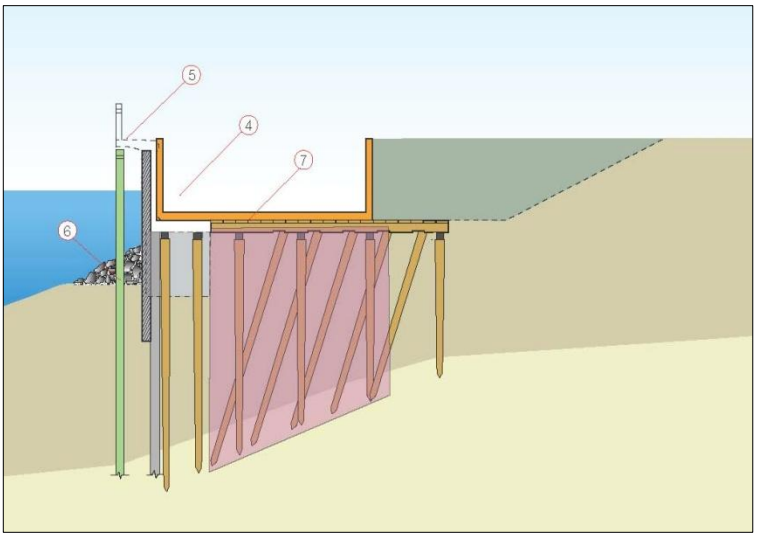
The anticipated construction activities and probable sequence for Alternative C, using soil improvement, are depicted below. The figures describe four primary stages of work that would occur along the waterfront. The activities within each zone would vary depending on the type of existing seawall present. Figures 1-14 through 1-17 are representative of the expected Alternative C construction sequence and depict the Type A seawall.



Alternative C, Stage 1

1. Place in-water containment curtain
2. Pre-drill and fill existing voids beneath timber relieving platform
3. Install soil improvement (jet grout)

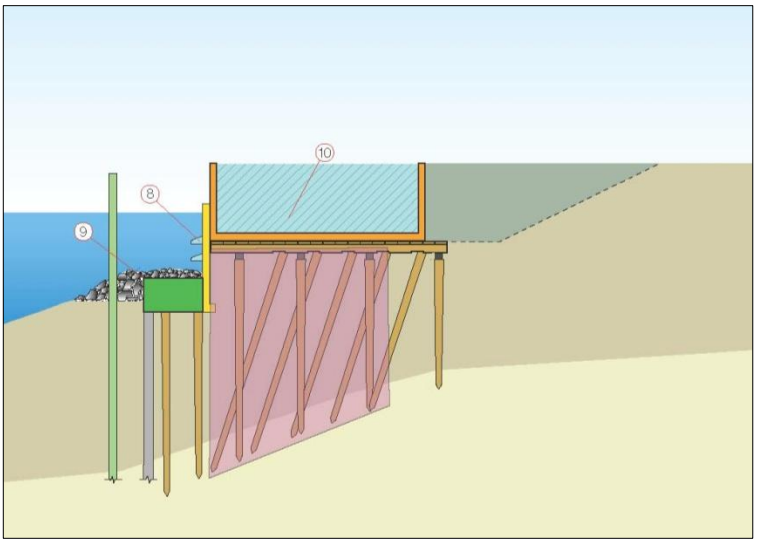
Figure 1-14. Alternative C, Stage 1



Alternative C, Stage 2

4. Relocate utilities
5. Remove existing sidewalk and pavement
6. Install temporary containment wall
7. Excavate to timber relieving platform

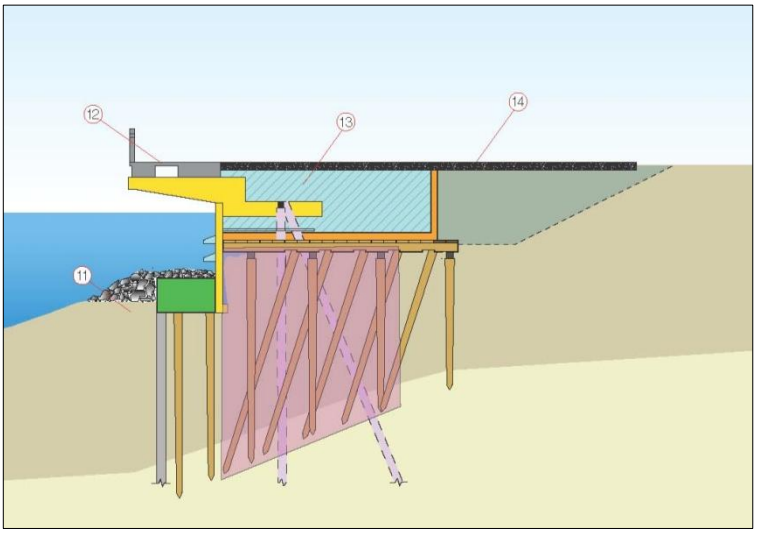
Figure 1-15. Alternative C, Stage 2



Alternative C, Stage 3

8. Remove portion of existing wall and install new face panels and habitat shelves
9. Place habitat bench

Figure 1-16. Alternative C, Stage 3



Alternative C, Stage 4

11. Remove temporary containment wall
12. Install cantilevered sidewalk with light penetrating surface
13. Restore utilities
14. Restore roadway for local traffic

Figure 1-17. Alternative C, Stage 4

TABLE 1-1. COMPARISON OF FEATURES OF THE THREE ELLIOTT BAY SEAWALL PROJECT BUILD ALTERNATIVES

Project Feature	Alternative A	Alternative B	Alternative C
Construction Method	Soil improvement	Braced soldier piles	Soil improvement
Central Seawall Construction Duration	3 construction seasons	5 construction seasons	3 construction seasons
North Seawall Construction Duration	4 construction seasons	4 construction seasons	4 construction seasons
Zone 1			
Face of Seawall Location	Existing location	0 to 15 feet landward	15 feet landward
Habitat Improvements	• Riparian plantings • Substrate enhancement • Cobble reef • Textured seawall face	• Riparian plantings • Substrate enhancement • Cobble reef • Expanded habitat bench and backshore	• Riparian plantings • Substrate enhancement • Expanded habitat bench and backshore
Upland Improvements	• Washington Street Boat Landing restoration • New or restored railings	• Washington Street Boat Landing restoration (up to 15 feet waterward of existing location) • Steps, boardwalk, and overlook (Option 1) • Short-stay boat moorage • New or restored railings	• Washington Street Boat Landing restoration (up to 15 feet waterward of existing location) • New or restored railings
Transportation Features	• Restored sidewalk • Restored multi-use trail • Restored roadway with additional northbound lane from S. Washington to Madison Street	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway with additional northbound lane from S. Washington to Madison Street
Zone 2			
Face of Seawall Location	15 feet landward	15 feet landward	15 feet landward
Habitat Improvements	• Confined substrate habitat bench • Textured seawall face • Intermittent LPS	• Confined substrate habitat bench • Textured seawall face • Continuous LPS	• Confined substrate habitat bench • Textured seawall face • Continuous LPS
Upland Improvements	• Same as existing	• Same as existing	• Same as existing
Transportation Features	• Restored sidewalk • Restored multi-use trail • Restored roadway with additional northbound lane from S. Washington to Madison Street	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway with additional northbound lane from S. Washington to Madison Street

Project Feature	Alternative A	Alternative B	Alternative C
Zone 3			
Face of Seawall Location	3 feet waterward	30 feet landward	10 to 15 feet landward
Habitat Improvements	• Confined substrate habitat bench and expanded habitat bench • Textured seawall face • Intermittent LPS at piers • Riparian plantings	• Confined substrate habitat bench and expanded habitat bench • Textured seawall face • Continuous LPS • Riparian plantings	• Confined substrate habitat bench and expanded habitat bench • Textured seawall face • Continuous LPS
Upland Improvements	• New or restored railings • Street plantings • Viewing area	• New or restored railings • Street plantings • Enhanced viewpoints with seating	• New or restored railings • Street plantings • Enhanced viewpoints
Transportation Features	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway
Zone 4			
Face of Seawall Location	10 feet landward	30 to 75 feet landward	10 feet landward
Habitat Improvements	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancements • Textured seawall face • Intermittent LPS at piers • Cobble reefs • Riparian plantings	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancements • Textured seawall face • Continuous LPS • Cobble reefs • Riparian plantings • Daylighting of water plaza	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancements • Textured seawall face • Continuous LPS • Daylighting of portions of cantilevered sidewalk
Upland Improvements	• New or restored railings • Street plantings • Viewing area	• New or restored railings • Street plantings • Creation of a land or water plaza • Enhanced viewpoints	• New or restored railings • Street plantings
Transportation Features	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway

Project Feature	Alternative A	Alternative B	Alternative C
Zone 5			
Face of Seawall Location	10 feet landward	10 feet landward	10 feet landward
Habitat Improvements	• Confined substrate habitat bench • Riparian plantings • Textured seawall face	• Confined substrate habitat bench • Riparian plantings • Textured seawall face	• Confined substrate habitat bench • Riparian plantings • Textured seawall face • Continuous LPS
Upland Improvements	• New or restored railings • Street plantings • Viewing area	• New or restored railings • Street plantings • Expanded viewpoints	• New or restored railings • Street plantings • Enhanced viewpoints
Transportation Features	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway	• Restored sidewalk • Restored multi-use trail • Restored roadway
Zone 6			
Face of Seawall Location	10 feet landward	10 feet landward	10 feet landward
Habitat Improvements	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancement • Textured seawall face • Riparian plantings • Intermittent LPS at piers • Cobble reefs	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancement • Textured seawall face • Riparian plantings • Intermittent LPS at piers • Cobble reefs	• Confined substrate habitat bench and expanded habitat bench • Substrate enhancement • Textured seawall face • Riparian plantings • Continuous LPS
Upland Improvements	• Restored or new railings • Viewing area	• Restored or new railings • Enhanced viewpoints	• Restored or new railings • Enhanced viewpoints
Transportation Features	• Restored sidewalk • Extended multi-use trail • Restored roadway	• Restored sidewalk • Extended multi-use trail • Restored roadway	• Restored sidewalk • Extended multi-use trail • Restored roadway

Note: LPS – light-penetrating surfaces

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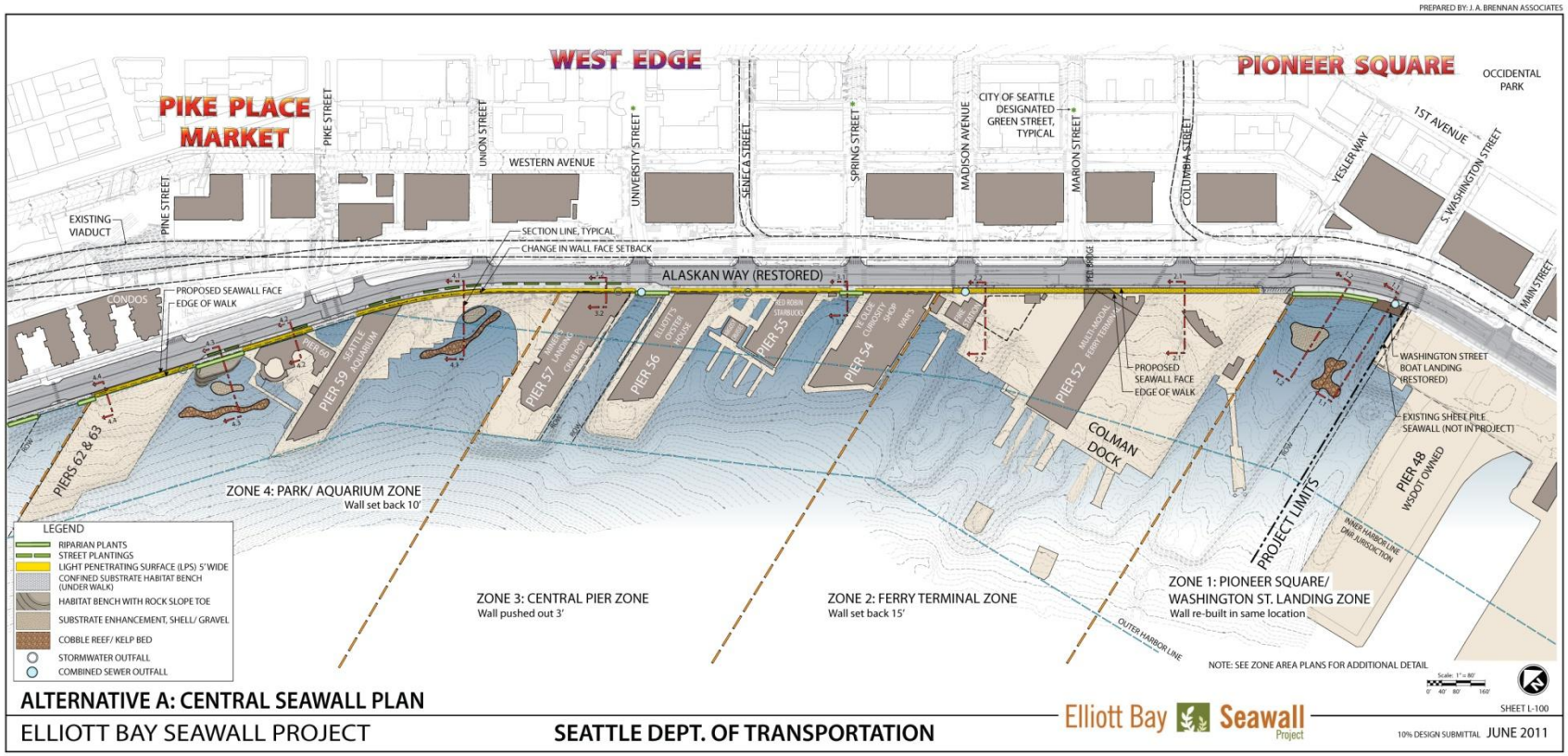

Figure 1-18. Alternative A: Central Seawall Plan

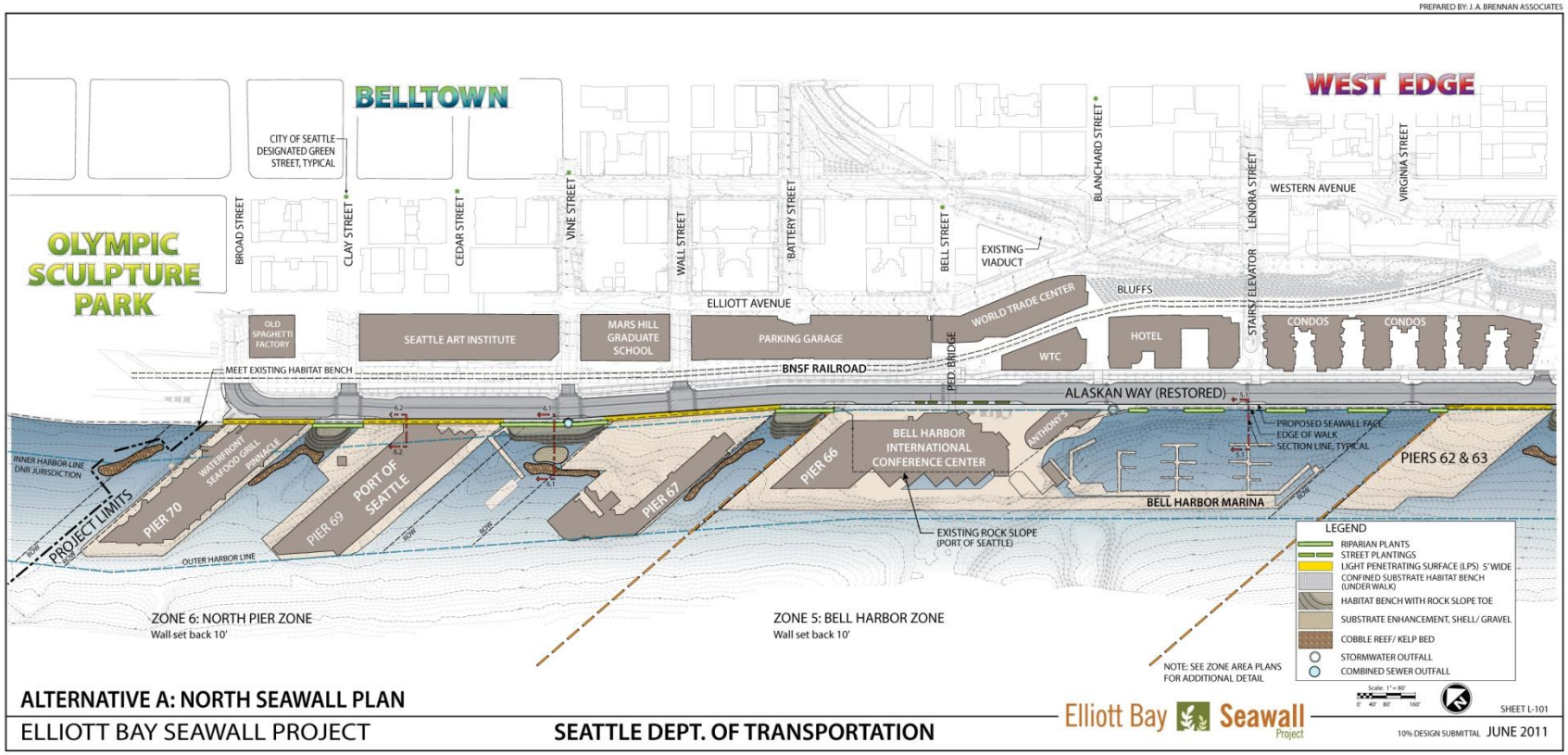

Figure 1-19. Alternative A: North Seawall Plan

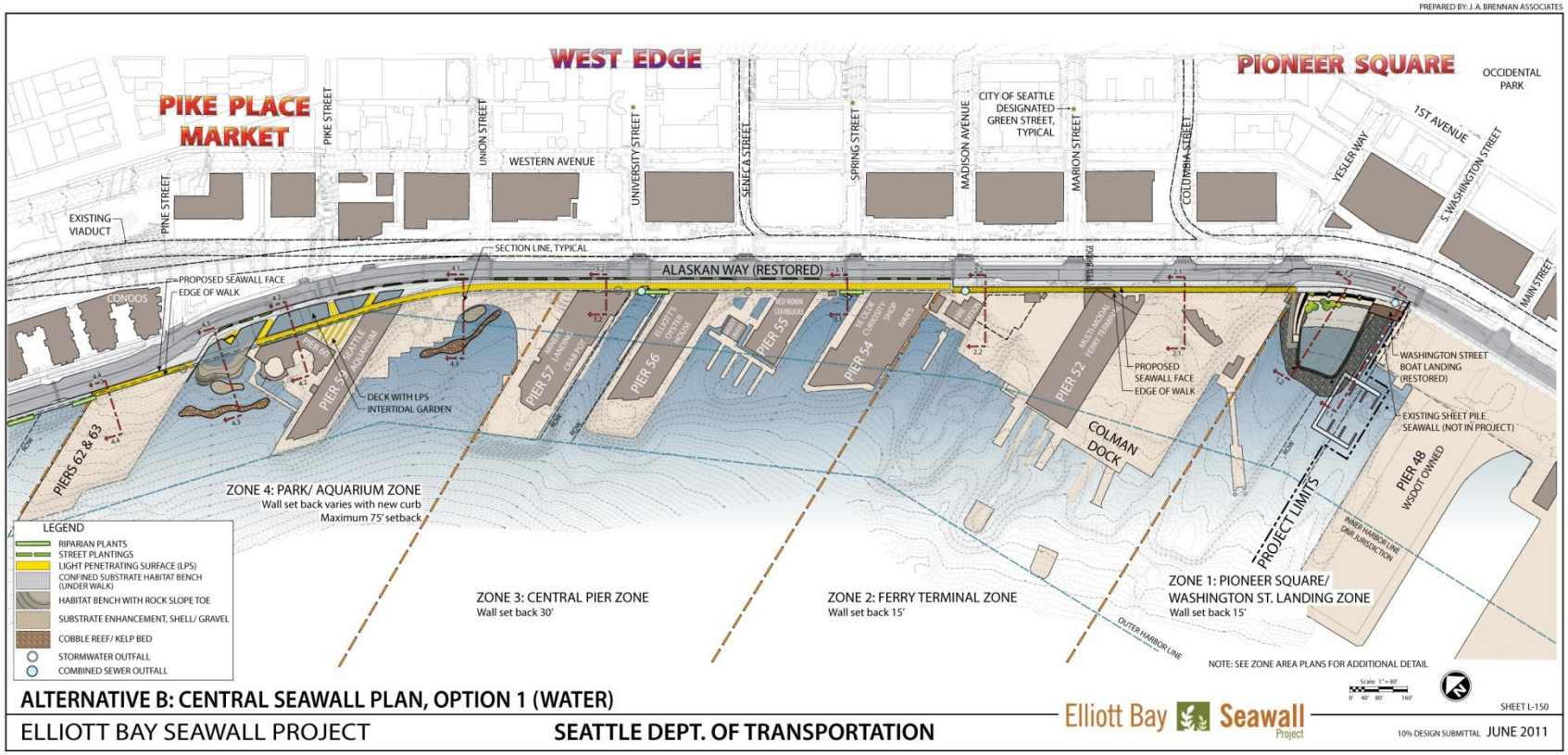

Figure 1-20. Alternative B: Central Seawall Plan, Option 1

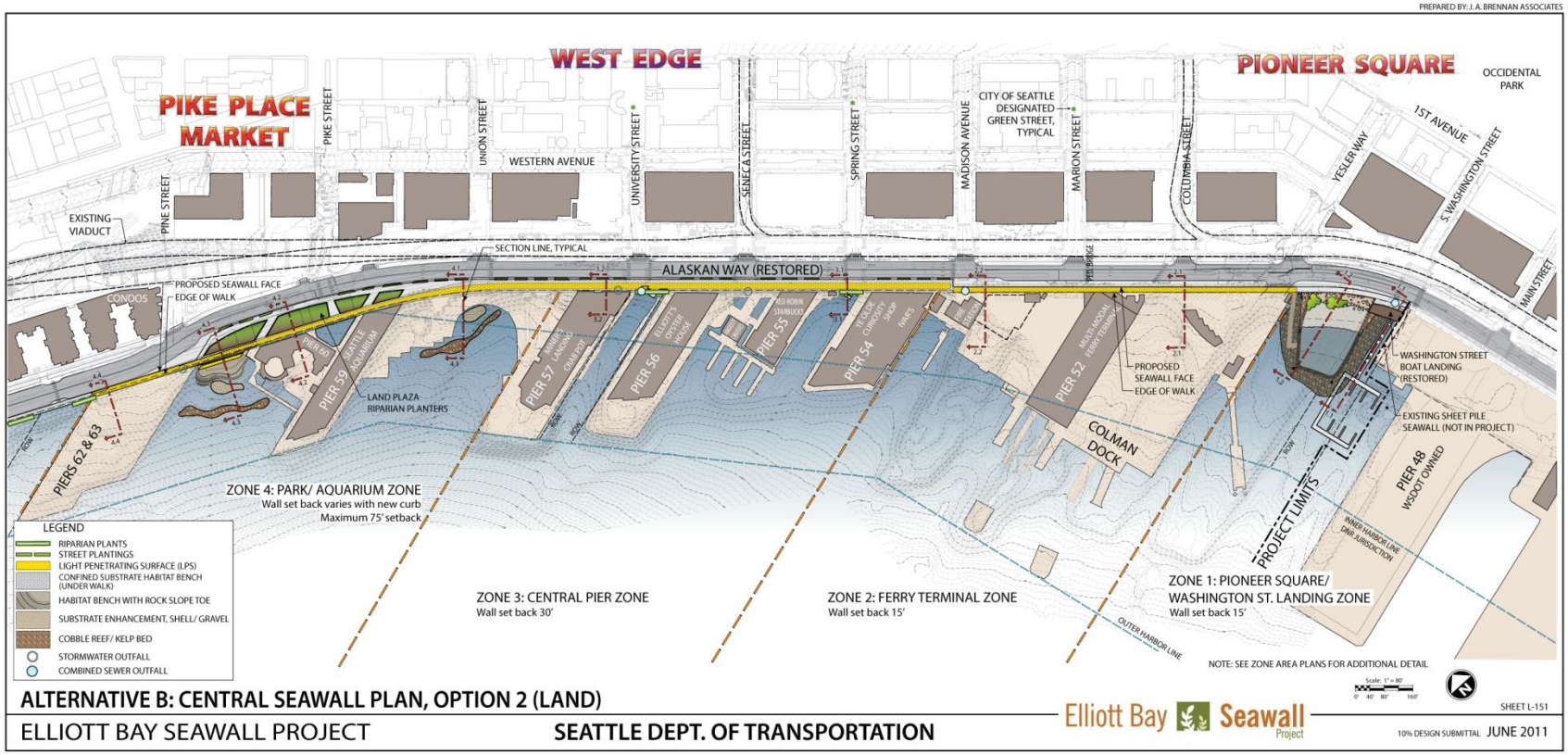

Figure 1-21. Alternative B: Central Seawall Plan, Option 2

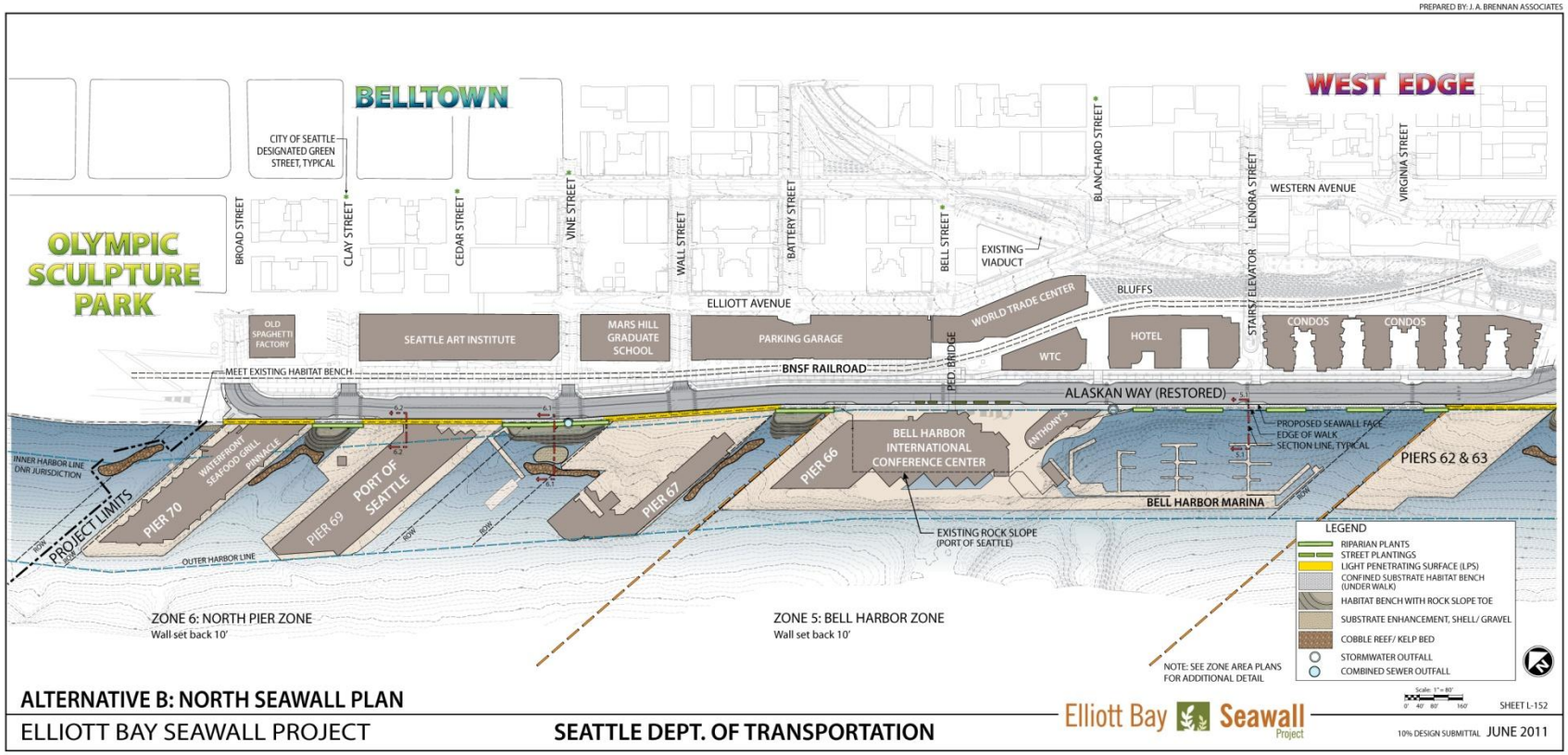

Figure 1-22. Alternative B: North Seawall Plan

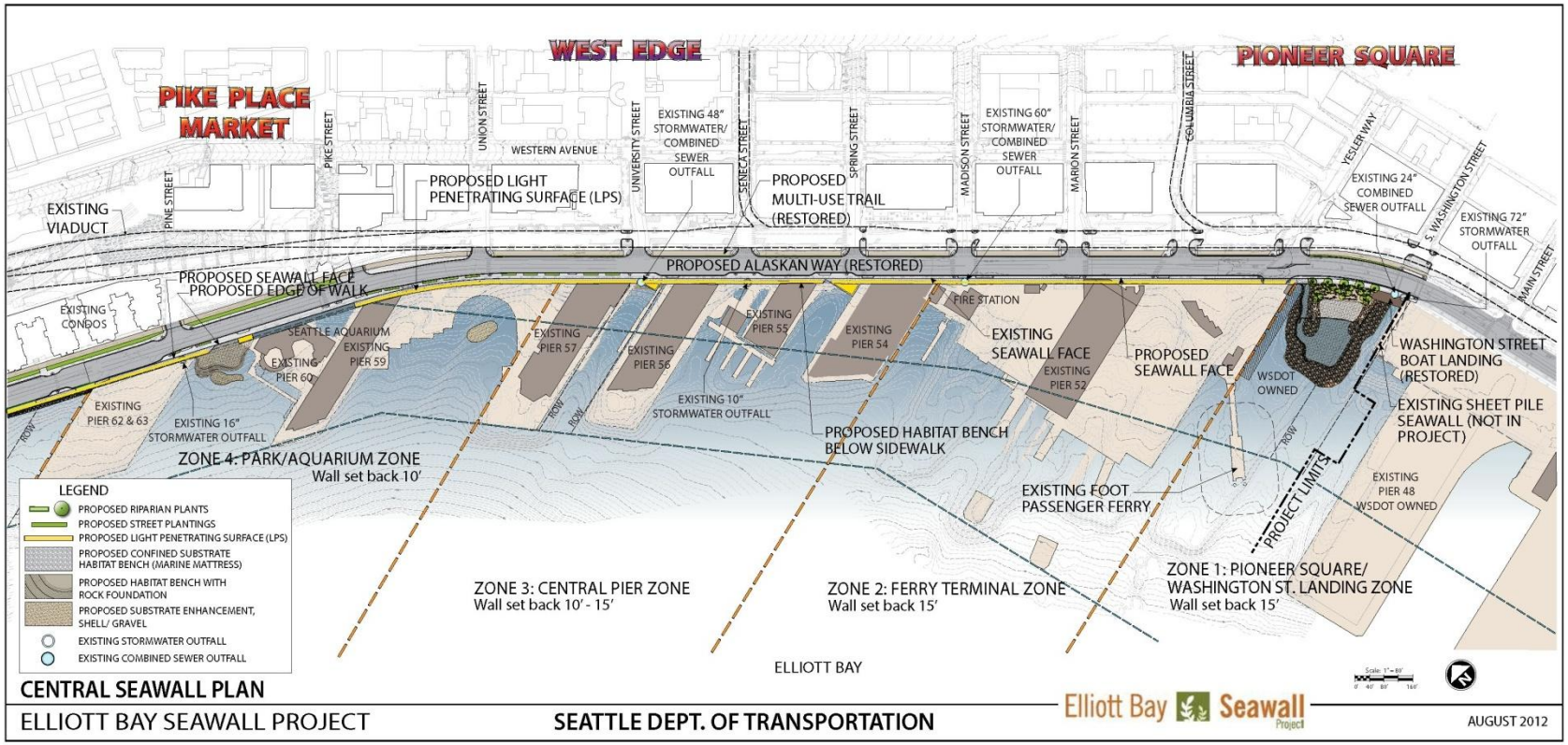

Figure 1-23. Alternative C: Central Seawall Plan

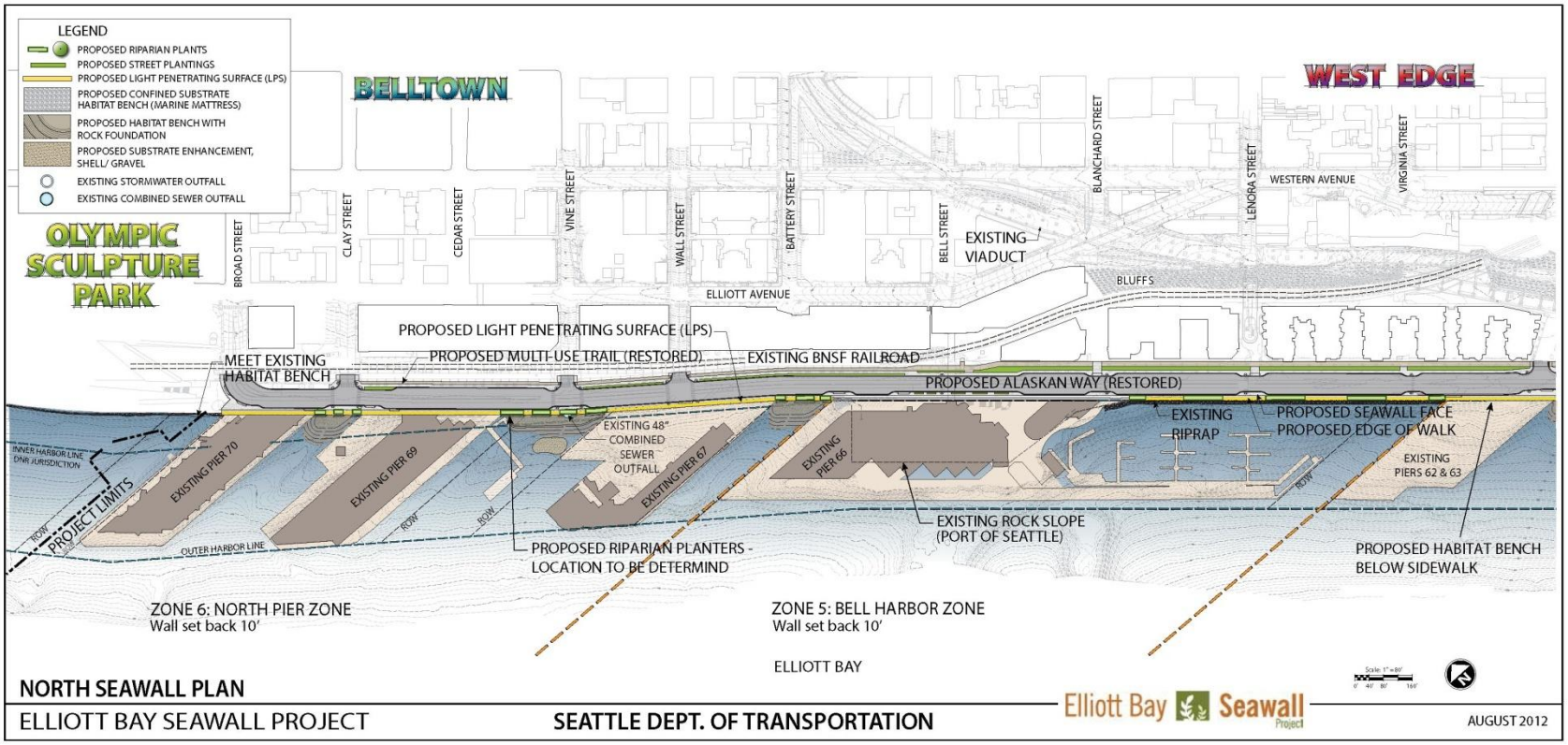

Figure 1-24. Alternative C: North Seawall Plan

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CHAPTER 2. METHODOLOGY

The final *Elliott Bay Seawall Project Fish, Wildlife, and Vegetation Methodology Technical Memorandum* (SDOT 2010) contains a detailed description of the methodology used for this Discipline Report. The following sections summarize the methodology implemented for evaluating fish, wildlife, and vegetation, and analyze project impacts for the build alternatives that are presented and evaluated for the EBSP. The fish, wildlife, and vegetation evaluation methodology assists engineering design efforts, such that biological resource management is appropriately considered in the design and alternatives evaluation, and appropriate habitat enhancements can be presented and evaluated.

2.1 PURPOSE OF THE FISH, WILDLIFE, AND VEGETATION DISCIPLINE REPORT

This Fish, Wildlife, and Vegetation Discipline Report evaluates the alternatives under consideration for replacing the Elliott Bay Seawall. This report and the EBSP Draft EIS that it supports are intended to assess the alternatives and potential environmental impacts associated with the EBSP. This Discipline Report presents the detailed technical analysis of existing conditions and predicted effects of each alternative.

2.2 DISCIPLINE STUDY OVERVIEW

This Discipline Report analyzes the conditions of existing biological resources within the EBSP study area that could be impacted by the replacement of the seawall. Construction of the new seawall by any of the build alternatives will have associated environmental effects, both beneficial and adverse, related to existing biological resources. This Discipline Report discusses design and construction as well as operational issues as they relate to biological resources and associated effects and mitigation. It also analyzes, as appropriate, these issues and effects in comparison with existing conditions in the EBSP study area associated with the conditions of a No Action Alternative.

2.3 EVALUATION METHODOLOGY

The affected environment discussion of this Fish, Wildlife, and Vegetation Discipline Report is based on an update of material initially prepared for the *Existing Conditions Report, Alaskan Way Seawall Replacement Project Feasibility Study* (USACE 2008). The affected environment sections on fish, wildlife, and vegetation presented in this Discipline Report provide an overview of the biological resources that currently exist in the study area. Each section includes an applicable description of the ecosystem and a summary of common taxa (group of organisms) found in the area including their spatial and temporal distributions. When available, data for historical conditions are referenced throughout the discussion to provide context for understanding the highly urbanized baseline conditions.

Various sources of information and data were used in the preparation of this Discipline Report. Primary sources of information include the following:

- Current information being collected as part of the EBSP;
- Alaskan Way Seawall Replacement Project Feasibility Study Existing Conditions Report (USACE 2008);

- City of Seattle: Recent monitoring and communications with key staff (SDOT, Seattle Public Utilities, Parks, etc.); Environmental Critical Areas and Shoreline Management Code;
- Washington State Department of Natural Resources (DNR): Washington Natural Heritage Program (WNHP) database of sensitive species recorded occurrences;
- King County: Environmental Services, recent monitoring and communications with key staff;
- Port of Seattle: Recent monitoring and communications with key staff;
- Burke Museum of Natural History and Culture and Seattle Aquarium;
- Puget Sound Partnership: Recent reports, communication with key staff to obtain any relevant unpublished data, project information;
- National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS): Northwest Region Species Lists, Essential Fish Habitat Mapper v2.0, Species Information database, and Ocean Acoustics Program;
- Tribes: data or information available from the Muckleshoot, Suquamish, Tulalip, Yakama and Duwamish Tribes;
- United States Army Corps of Engineers (USACE) available reports and permit monitoring reports pertaining to Elliott Bay;
- United States Department of Agriculture (USDA) Plants Database;
- United States Department of Fish and Wildlife Service (USFWS) Species Lists by County, Species Profile database, Threatened and Endangered Species System (TESS), Endangered Species Program, and Critical Habitat Portal;
- University of Washington: recent theses, dissertations, and reports; communications with researchers conducting work in vicinity;
- Washington Department of Fish and Wildlife (WDFW) Priority Habitat and Species (PHS) data, WDFW - Living with Wildlife;
- Washington State Department of Ecology (Ecology): Publications and communications with key staff;
- Washington Department of Natural Resources (DNR) Natural Heritage Program; and
- Other sources: data from past and ongoing field surveys of the study area, recently published species accounts and range maps, past and contemporary primary literature, gray literature such as unpublished and published reports, and data obtained through conversations with professional biologists familiar with the ecosystem of interest.

Several targeted surveys were undertaken to gain a better understanding of the current nearshore habitat condition and anadromous fish use in the project vicinity. A field survey of nearshore habitats was completed for the study area. It consisted of an underwater survey to map habitat types present along the length of the seawall to a width of 100 linear feet perpendicular to the wall except for at Piers 48 and 62/63, which were surveyed to the end of each pier (SDOT 2011). The resulting data documented habitat and substrate type as well as identified distributions of dominant macroalgae and invertebrate species. Nearshore fish surveys were completed in 2011 and are currently being performed to quantify timing, use, and densities across seasons of various fishes including salmonids (SDOT 2011). Methods

include snorkel surveys and land-based visual surveys within the study area and occurred at regular intervals throughout 2011 (Anchor QEA 2012). The University of Washington is continuing these surveys and adding a study of diet of various fish species on a seasonal basis in 2012 and 2013. Although these surveys are ongoing, up-to-date preliminary results are incorporated into this document and are being used to refine the design of the alternatives. As the surveys proceed, they will provide supplemental data on species distributions, timing, and salmonids species and age assemblages in the study area. Data from these surveys will be incorporated into future reports and the ongoing design. A shoreline survey of bull kelp distribution from Olympic Sculpture Park to Pier 48 was completed in 2010 (Anchor QEA 2010). The resulting maps indicate the location and density of all existing patches of bull kelp growing to the water surface (Anchor QEA 2010).

Physical properties of the study area include some key features that are important to know in order to understand the biological processes that occur in the study area. Each feature shapes, and is shaped, by the abiotic and biotic environment, and knowledge of where each feature is located in the study area is essential to understanding these interactions. These features are used throughout this Discipline Report to discuss all aspects of the biological resources. The location of each feature is illustrated in Figure 2-1, a typical cross section of the study area.

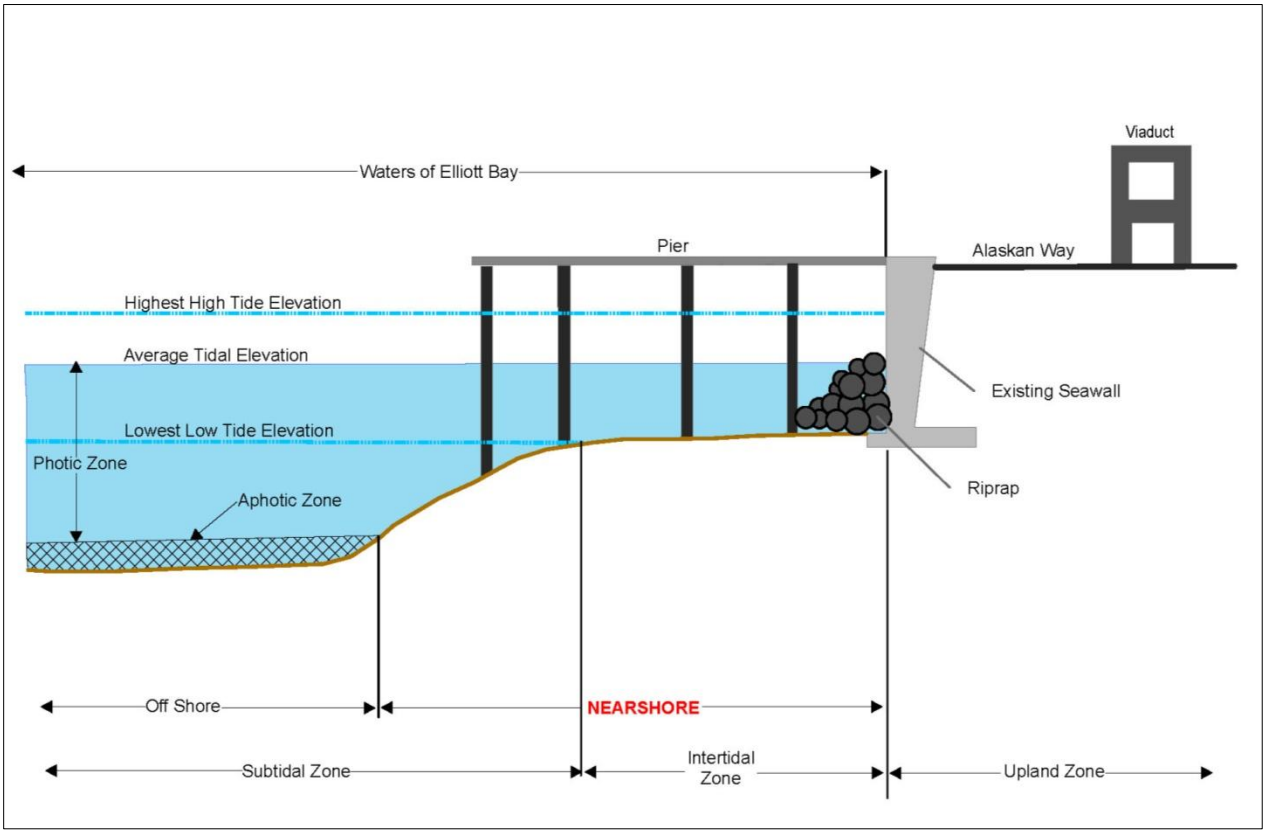


Figure 2-1. Typical Cross Section of the Elliott Bay Seawall Project Area Showing Important Physical Biological Features (Note: figure not to scale)

Existing biological resources are discussed in a framework intended to facilitate the assessment of potential impacts caused by each alternative (including the No Action Alternative). All biological resources are discussed including vegetation, fisheries, wildlife, and listed species and habitats. Analysis of impacts primarily discusses effects on listed species and habitats. Cumulative impacts are also assessed and discussed for each alternative.

Mitigation is considered in the context of avoiding, minimizing, and, if necessary, providing compensatory mitigation for unavoidable adverse effects. First consideration is given to methods to avoid impacts to fish, wildlife, and vegetation resources. Best Management Practices (BMPs) are presented and discussed as a means to minimize the potential for adverse effects due to the proposed project. BMPs are intended to reduce impacts to biological resources, including federally-listed species and sensitive habitats due to proposed project actions. Specific BMPs will be determined based on the expected types of impacts. Compensatory mitigation measures are presented as a possible means to compensate for any unavoidable adverse effects to biological resources including federal- and state-listed species and sensitive habitats. It should be noted that the proposed habitat enhancements of the build alternatives would largely eliminate any potential adverse effects incurred on the biological resources in the project area.

Cumulative and indirect (secondary) effects are also analyzed. The focus of the cumulative effects analysis is an evaluation of the combined effects on biological resources, including species of special concern and sensitive habitats for each proposed alternative of all of the past, present, and reasonable and foreseeable projects in the study area. A master list of current and reasonably foreseeable future projects has been identified and includes the Alaskan Way Viaduct Replacement Project (Bored Tunnel Alternative) and Waterfront Seattle. Indirect effects are defined as effects caused by the action which occur later in time or farther removed in distance but are still reasonably foreseeable, are also identified and described in the discussion. Unlike direct effects, indirect effects are imbedded in the chain of cause-and-effect relationships and therefore are more complex. Indirect effects have been determined through communication with agencies and professional biologists that are familiar with the local ecosystem and sources of impacts, and from best professional judgment.

CHAPTER 3. COORDINATION AND INFORMATION SOURCES

This chapter summarizes the document coordination, data review and information sources used to identify important biological resources that may be present within the study area. The final *Elliott Bay Seawall Project Fish, Wildlife, and Vegetation Methodology Technical Memorandum* (SDOT 2010) contains a detailed description of the methodology used for this Discipline Report and was used as guidance. Many sources of information, including literature, coordination, and research data and results were all extensively referenced in the development of this Discipline Report.

3.1 DOCUMENT REVIEW

Document review occurred during the first phase of work as part of the "early start" activities. The primary activities included cataloging existing data and documents and subsequent document review. All applicable and readily-available data and documents were identified from various research libraries, the City, and concurrent research performed by Anchor QEA and the University of Washington (UW); reports and plans that have been collected for the Alaskan Way Viaduct and Seawall Replacement Program, Alaskan Way Viaduct Replacement Project, and other nearby projects relevant to the study area; and from online sources including local and state regulatory agencies. Information and data compiled within several other EBSP Discipline Reports (i.e., Contaminated Materials, Water Resources, Geology and Soils, and Noise and Vibration [SDOT 2012a, 2012b, 2012c and 2012d, respectively]) were also referenced and used in the writing of this Discipline Report. Information from these sources was subsequently reviewed and cataloged based on relevancy of the data related to biological resources found in upland and nearshore areas along the existing seawall within the defined limits of the study area.

Data and documents made available by the City that were identified as most relevant during the cataloging phase of work were initially reviewed and subsequently documented in the *Elliott Bay Seawall Project Fish, Wildlife, and Vegetation Methodology Technical Memorandum* (SDOT 2010). During the review process, additional documents were made available by the City that were subsequently evaluated for relevant information and incorporated into the catalog. Documents that were readily available in digital format were incorporated into the EBSP project-specific library.

Existing location maps obtained from the most relevant documents were scanned, digitized, and georeferenced in a Geographic Information System (GIS).

3.2 EXISTING ENVIRONMENTAL DOCUMENTATION

3.2.1 Affected Environment

Fish, wildlife, invertebrate and plant species common to the project area were identified by two means: using data from recent and current field surveys and summarizing current published species-range data. Data on species abundance and diversity in the study area were incorporated as available. Data illustrating potential human-caused fitness reductions in local populations through contaminant loading or biomagnification were also incorporated when available.

General background information on biological resources such as general habitat features of the proposed project area was compiled using publications from local and federal agencies, professional documents, primary literature and gray literature (when appropriate). Other non-published sources were incorporated; these include communications with professional biologists experienced in the study area and data from past, ongoing, and/or planned field surveys associated with the EBSP.

3.2.2 Species of Special Concern

The most current, spatially appropriate lists of species of special concern were obtained and applicable information regarding each species was incorporated into the Discipline Report. Species lists were obtained through online resources provided by NOAA, USFWS, and WDFW, and through direct coordination with these agencies. Accessing agency online resources provided an opportunity to obtain pertinent and important data such as historical biology, current distribution, natural history and population status for each species. WDFW maintains their PHS database that identifies species and habitats determined to be priorities based on defensible criteria; provides spatial data and information on the conditions required to maintain healthy populations; and provides consultation and guidance on land use issues affecting these species. The information provided by PHS was used primarily to describe local populations of species of special concern. Additional species data specific to the EBSP area were obtained from the Natural Heritage Program and from other local sources. Whenever possible, historical data such as past population assessments or survey data were incorporated into this Discipline Report to provide additional context for illustrating local population trends of species of special concern found in the study area.

Information on sensitive habitats supporting species of special concern was obtained from federal and state agencies. Critical habitat has been identified by federal agencies for some species of special concern that occur in the EBSP project area. Additional federal protection has been designated for habitats essential to managed species and measures to conserve and enhance this habitat. This protection requires cooperation among NOAA, the Fishery Management Councils, and federal agencies to protect, conserve, and enhance essential fish habitat (EFH). Priority Habitat and Species provides comprehensive information on habitat resources in Washington State, which is recommended to be used by local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes.

3.3 REGULATORY FRAMEWORK: FEDERAL, STATE, AND LOCAL PROTECTION OF BIOLOGICAL RESOURCES

Several federal, state, and local regulations govern decisions and management concerning the potential for impacts on biological resources. The following paragraphs describe the plans, acts and agreements that have been established to protect the sensitive biological resources found in the proposed project area.

NEPA and SEPA established legal requirements that the EBSP will follow. The Endangered Species Act (ESA) of 1973, as amended, declares that all federal agencies "…utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act." Section 7 of the ESA requires federal

agencies to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of any threatened or endangered species. The ESA further requires the federal government to designate "critical habitat" for any species it lists under the ESA. Other federal protection potentially applicable to this Discipline Report includes:

- Marine Mammal Protection Act (MMPA; 16 U.S.C. 1361), which prohibits "take" of all marine mammals unless under special circumstances.
- Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act, which is intended to promote the United States fishing industry's optimal exploitation of coastal fisheries by “consolidating control over territorial waters.”
- Migratory Bird Treaty Act (16 U.S.C. 703-712), which states that all migratory birds and their parts (including eggs, nests, and feathers) are fully protected.
- Fish and Wildlife Coordination Act (16 U.S.C. 661-667), which provides the basic authority for the involvement of the USFWS in evaluating impacts to fish and wildlife from proposed water resource development projects.
- Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), which protects bald and golden eagles by prohibiting, except under certain specified conditions, "take," possession, and commerce of such birds.
- Clean Water Act Section 402, which is intended to control nonpoint pollution sources that affect coastal water quality.
- Section 401/404 of the Clean Water Act, which regulates the discharge of dredged or fill material into waters of the United States, including wetlands.
- North American Waterfowl Management Plan (1986; updated in 1998), which provides "a strategy for cooperation in the conservation of waterfowl."

Section 6 of the ESA provides a mechanism for cooperation between federal agencies and states in the conservation of threatened and endangered species. Under Section 6, federal agencies are authorized to enter into agreements with any state that establishes and maintains an "…adequate and active…" program for the conservation of endangered and threatened species; such an agreement has been reached with Washington State (RCW 77.12.320). Once a state enters into an agreement, federal agencies are authorized to assist in, and provide federal funding for the implementation of the state's conservation program, which in this case, is managed by WDFW through their PHS program. Additional guidelines set by Washington State that are potentially applicable to the EBSP are:

- Bald Eagle Protection Rules (WAC 232-12-292; RCW 77.12.655);
- WDFW Hydraulic Project Approval (HPA);
- Shoreline Management Act of 1971 (RCW 90.58.10 through 90.58.920);
- DNR Aquatic Land Management; and
- Critical Areas Regulations described in the Growth Management Act (RCW 36.70A.060).

The City of Seattle Comprehensive Plan (Ordinance 117221) and Tribal fishing rights at "usual and accustomed" fishing locations have also been considered in the preparation of this Discipline Report as well as in the Social Resources and Environmental Justice Discipline Report (SDOT 2012e).

Sensitive fish, wildlife, and plant species considered in the discussion presented in this Discipline Report include those listed under the ESA and by the State of Washington.

3.4 SURVEYS CONDUCTED DURING THIS STUDY

Several additional field studies were conducted as part of the EBSP. A field survey of nearshore habitats was completed for the study area. It consisted of an underwater survey to map habitat types present along the length of the seawall to a width of 100 linear feet perpendicular to the wall except for at Piers 48 and 62/63, which were surveyed to the end of each pier (see Anchor QEA 2011a). The resulting data documented habitat and substrate type as well as identified distributions of dominant macroalgae and invertebrate species. Nearshore fish surveys were performed in 2011 to quantify timing, use, and densities across seasons of various fishes including salmonids (see Anchor QEA 2012). Methods included snorkel surveys and land-based visual surveys within the study area and occurred at regular intervals throughout 2011. The University of Washington is continuing these surveys and adding a study of diet of various fish species on a seasonal basis in 2012 and 2013. Although these surveys are ongoing, current results are incorporated into this document and are being used to refine the design of the alternatives. As the surveys proceed, they will provide supplemental data on species distributions, timing, and salmonids species and age assemblages in the study area. Data from these surveys will be incorporated into future reports and the ongoing design. A shoreline survey of bull kelp distribution from Olympic Sculpture Park to Pier 48 was completed in 2010 (see Anchor QEA 2010). The resulting maps indicate the location and density of all existing patches of bull kelp growing to the water surface.

CHAPTER 4. AFFECTED ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

The study area considered for the Fish, Wildlife, and Vegetation Discipline Report focuses primarily on the area extending from S. Washington Street in the south to Broad Street in the north (Pier 48 through 70), Western Avenue in the east, and the approximate 50-foot (15.2-meter) bathymetric contour to the west (which generally corresponds to the outer edge of the piers). However, because impacts from activities such as pile driving have the potential to extend further across all of Elliott Bay, organisms and habitats found in deeper waters are also considered and discussed in this Discipline Report.

The EBSP study area is located on the eastern shore of Central Puget Sound, forming part of one of the world's largest and deepest estuaries (Kruckeberg 1991). Elliott Bay also has the distinction as being one of the most heavily urbanized and polluted areas in Puget Sound (City of Seattle 2009; Anchor QEA 2012). Recently, however, habitat in nearby locations has been partially restored (see King County DNR 2003; Seattle Art Museum 2004; Port of Seattle 2005) incrementally improving the overall ecosystem.

4.2 HISTORICAL CONDITIONS

Historically, the EBSP study area consisted of gravel beaches, intertidal mud and sand flats, and vegetated wetlands bordered by steep upland bluffs (Blomberg et al. 1988; Tanner and Clark 1999). Through more than 100 years of urbanization, the waterfront of downtown Seattle was fundamentally altered through filling, dredging, and grading along the shoreline (Weitkamp et al. 2000), and the construction of infrastructure including the seawall, other shoreline armoring, and overwater structures.

4.3 CURRENT CONDITIONS

Currently, very little natural shoreline, upland or intertidal aquatic habitat exists in the study area. Overwater structures occupy over 65 percent of the shoreline of Elliott Bay (Tanner and Clark 1999), blocking light from penetrating into much of the nearshore during the day (Curtiss et al. 2006) and exposing the nearshore to artificial light from urban sources at night (USACE 2010). Nearshore bathymetry has been highly altered through the establishment of the waterfront and maintenance of vessel moorage. Dredging for vessel access has caused shallow sea bottom to be restricted to under existing piers or former pier sites, deep water to predominate between piers (Taylor 1995; Weitkamp et al. 2000), and a shallow shoreline. One exception is the area found north of Pier 48 which is generally shallow and has a gravel intertidal bench. Substrates found throughout the littoral and shallow subtidal zones are largely composed of either riprap lying at the base of the seawall or a sand/silt/shell hash mix which dominates the deep subtidal in most locations (Taylor Associates 2006; Curtiss et al. 2006; USACE 2008; City of Seattle 2010; SDOT 2011) although areas with accumulations of miscellaneous rubble and downed pilings are also present. Suspended fine sediments from multiple sources, including the Green/Duwamish River, stormwater runoff, combined sewer overflow (CSO) outfalls, and past industrial and commercial activities have accumulated in the nearshore. These sediments are known to contain various pollutants such as polycyclic aromatic hydrocarbons (PAHs), including benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene; and metals, including arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials

Discipline Report [SDOT 2012a] and Water Resources Discipline Report [SDOT 2012b] for details). Known locations in the proposed project area with high concentrations of these pollutants include the Colman Dock Sediment Site (Piers 51 and 52) in Zone 2, Central Waterfront Sediment Site (Piers 54 through 57) in Zone 3, between Piers 57 and 59 and between Piers 59 and 62/63 in Zone 4, south of Pier 67/68 in Zone 5, and between Piers 69 and 70 in Zone 6.

Although water quality in the proposed project area generally meets standards set by the State of Washington, it has been degraded through continual urban land use that began before the construction of the existing seawall. Pollutants found in Elliott Bay waters include benzo(a)pyrene, total and dissolved zinc, total and dissolved copper, and total suspended solids (USACE 2008; also see the Water Resources Discipline Report [SDOT 2012b] for details).

All of the natural shoreline in the study area has been replaced by the seawall, although adjacent areas with less armoring retain some natural function (Blomberg et al. 1988; Tanner and Clark 1999). Some areas of the seawall have had various designs of artificial substrate installed to test their effectiveness in enhancing the nearshore environment (summarized in Curtiss et al. 2006). Upland areas also have been fundamentally altered through urban development, leaving virtually no natural habitat intact. What upland habitat remains is fragmented and degraded by pollution, disturbance and the introduction of exotic species (USACE 2008).

Background noise in the project area has been shown to be generally loud. Noise generated by urban activities such as vehicle traffic, use of machinery, container shipping, and ferry and other boat traffic radiates into and through all environments. Measured ambient noise conditions in the marine environment in the vicinity of the EBSP was recorded to be 126 dB_{RMS} (Laughlin 2011); a value substantially higher than natural conditions. Thus, the entire action area, both in the marine and upland environments, has high ambient noise levels.

4.3.1 Vegetation

Although the vegetation in the EBSP study area is substantially altered compared to its historic and natural state, a diversity of species are established in marine and upland habitats. The upland plant assemblage is composed mainly of planted exotics (i.e., non-natives). However, native species dominate the aquatic nearshore plant assemblage. Marine algae, including blue-green algae (cyanophyta), green algae (chlorophyta), diatoms (bacillariophyta), brown algae (phaeophyta), and red algae (rhodophyta) are found throughout the nearshore in areas where light reaches the substrate. Vascular flowering plants (magnoliophyta) are also found in the nearshore, although the shallow flats they require are now mostly absent from the study area.

4.3.1.1 Marine Vegetation

Historically, the intertidal mud and sand flats in the study area (Blomberg et al. 1988; Tanner and Clark 1999) hosted a rich variety of bacillariophyta diatoms (which appear like patches of olive-brown scum) and various species of chlorophyta and rhodophyta including sea lettuce (*Ulva* sp.), *Enteromorpha* spp., and *Smithora* spp. (Kozloff 1993; AlgaeBase 2011). Marine vascular flowering plants (magnoliophyta) such as eelgrass (*Zostera marina*) and surfgrass (*Phylospadix* spp.) were also likely common, growing in

sandy or muddy-bottomed areas of reduced wave action (Kozloff 1993; AlgaeBase 2011). Although most of these species are present in the study area today, their distribution and abundance are fundamentally different due to the reduction of natural substrate, areas that receive natural light, and water and sediment quality, as well as a substantial increase in hard surfaces and disturbance from boat traffic.

Currently, numerous species of chlorophyta, phaeophyta, and rhodophyta reside in the nearshore (Figure 4-1). Artificial structures such as floating docks and wood pilings are dominated by sea lettuce (*Ulva lactuca*) and rockweed (*Fucus gardneri*) (each providing approximately 20 percent cover) in addition to various rhodophyta species (less than 20 percent cover) (USACE 2008; SDOT 2011). Sugar wrack (*Saccharina latissima*) is also associated with these structures (less than 20 percent cover), as is *Codium fragile*, *Polyneura latissima*, and *Membranoptera platyphylla* (USACE 2008; SDOT 2011). These species maintain patchy distributions and relatively low densities (USACE 2008). Other substrates in the nearshore include riprap, cobble, gravel, sand, silt, concrete and other debris. Riprap is commonly found at the base of the seawall while quarry spalls are scattered from the lower portion of the intertidal zone down through the subtidal zone (USACE 2008; SDOT 2011). Sand is found primarily in the deeper subtidal zone but is also present beneath most piers and in the intertidal habitat bench located immediately north of Pier 48 (USACE 2008; SDOT 2011). Larger rocky substrate, greater than gravel in size, provides a source of attachment for algae such as *Fucus spiralis*, *Endocladia muricata*, *Gigartina papillata*, feather boa kelp (*Egregia menziesii*), *Corallina* sp. and winged kelp (*Alaria* sp.), which are associated with cobble, riprap and concrete (USACE 2008). Mats of bull kelp (*Nereocystis lurtkeana*) are present along the seawall in discrete patches between piers. Relatively large patches (between 100 and 300 stipes) are located north of Piers 69, 67/68, 66, and between Piers 62 and 59; numerous smaller patches (between 1 and 50 stipes) are found throughout the rest of the nearshore (USACE 2008; Anchor QEA 2010). This distribution appears to be associated with the presence of rocky substrate for attachment, water depths between seven and 15 feet, and areas protected from boat-caused wave action (USACE 2008). Areas of sandy substrate with sun exposure, although limited to approximately 200 square feet at the Pier 48 intertidal habitat bench (at low tide) and to small patches north of Pier 57 and south of Pier 62/63, provide potential habitat for eelgrass and surf grass (Kozloff 1993; NRC 2001; City of Seattle 2006; USACE 2008; Mumford 2007); however, little is currently present. The presence of numerous overwater structures in the study area stop natural light from penetrating into the nearshore and prevent plant growth in areas beneath the structures.

Areas with native-type vegetation are found surrounding the study area. The shallow subtidal sand flats and other remnant sandy subtidal areas between Alki Point and Duwamish Head support productive eelgrass beds that have been shown to be important to a variety of marine organisms, including juvenile anadromous fish (KCDNR 2001). SCUBA surveys performed along the Olympic Sculpture Park shoreline to the north of the study area documented 23 species of algae on and near the created habitat bench. In this area, algae percent-cover ranged from between 46 to 74 percent and kelp beds were document as thriving and providing necessary habitat for various native fish and invertebrates (Toft et al. 2008; Toft et al. 2010).

No eelgrass has been observed in the Elliott Bay Seawall Project area. Eelgrass may have historically occurred in the area but the current bathymetry and substrate is unsuitable for this aquatic plant.

Figure 4-1. Algae Found in the Study Area;
bottom photo shows lack of marine plants and other organisms under overwater structures
(photo source: SDOT 2011)

4.3.1.2 Upland Vegetation

Upland plants are present in the study area; however, common species are almost exclusively exotics that have become established in ruderal areas (i.e., areas frequently disturbed by human activities) or have been planted as ornamentals. Naturally established plants are weedy and well adapted to disturbance and urban environments with the ability to grow in areas most native species find inhospitable. Some hardy species documented in the area include exotics such as English ivy (*Hedera helix*), Himalayan blackberry (*Rubus armeniacus*) and butterfly bush (*Buddleja* sp.) which grow from cracks and fissures in sidewalks, piers and pilings, and in ruderal patches of soil (Figure 4-2). Native species such as western brackenfern (*Pteridium aquilinum*), leathery polypody (*Polypodium scouleri*), sword fern (*Polystichum munitum*) and trailing blackberry (*Rubus ursinus*) also grow opportunistically in the same areas as the exotic species (USACE 2008). Non-vascular plants such as mosses (bryaceae) and lichens (fungi) grow on a variety of hard surfaces such as concrete, treated wood, and occasionally on metal. Planted, ornamental exotic species are the dominant vegetation features of the upland. Common trees include maples (*Acer* spp.) and liquidambar (*Liquidambar* spp.), and potted plants such as ornamental cherry (*Prunus* spp.), arborvitae (*Thuja occidentalis*), begonias (*Begonia* spp.), violets (*Viola* spp.) and geraniums (*Geranium* spp.). A substantial upland restoration occurred adjacent to the north end of study area as part of the Seattle Art Museum Olympic Sculpture Park Project (see Seattle Art Museum 2004). A large part of the project included planting native riparian plant species along the walking path on top of the seawall. This effort appears to have been largely successful in reestablishing native plant species in the surrounding urban landscape.

4.3.2 Invertebrates

Various invertebrate species occur in pelagic, benthic and upland habitats of the study area. Included are species of jellyfish and anemones (cnidariana), sponges (porifera), mollusks (molluska), crustaceans and barnacles (arthropoda), starfish and allies (echinoderma), annelids (annelida) and tunicates (urochordata). Terrestrial insects (arthropoda), which are important in the greater ecosystem as a prey source both in and upland of the nearshore, are also found in the study area. Species identified in the study area and discussed in this section are grouped under the habitat type in which they spend the majority of their adult life stage; pelagic, benthic or terrestrial zones. Marine borers, various taxa of invertebrates that burrow into wood and other hard materials, have substantially contributed to the deterioration of the existing seawall.

4.3.2.1 Pelagic Invertebrates

The pelagic zone, which makes up the western edge of the study area where water is deeper than sunlight can penetrate, hosts invertebrates that primarily move passively (i.e., with water movement) or primarily by active propulsion. Zooplankton is an extremely diverse group of mostly passive-moving animals, including the larval stage of dozens of marine and estuarine taxa of many phyla. In Elliott Bay, zooplankton is composed mostly of copepods, but amphipods, mysids, various species of fish larvae, and euphausiids are all also in abundance (Strickland 1983; Battelle et al. 2001; Toft and Cordell 2006). Demographics of zooplankton in Elliott Bay are not well understood; however, they are known to provide important prey base for many species including anadromous fish.

Figure 4-2. Upland Vegetation Found in the Study Area

Squid species such as market squid (*Loligo opalescens*) and occasionally boreoatlantic armhook squid (*Gonatus fabricii*) are common nocturnal visitors to the pelagic zone of the study area (Kozloff 1993; KCEL 1998; USACE 2008; City of Seattle 2010b). These species are most common in the nearshore in October and November, when they move into shallow waters to feed, breed and lay eggs (Kozloff 1993; KCEL 1998; USACE 2008; City of Seattle 2010b). They are known to be attracted to artificial light and are lured near the piers by anglers with spotlights. A popular fishery exists for these species with most of the fishing occurring off of Pier 86; although, all piers in the study area are used for angling at times (USACE 2008). Little else is known about the distribution and abundance of these species in the study area;

however, it is thought that frequency and timing of their appearance and the appearance of the uncommon Humboldt squid (*Dosidicus gigas*) may be changing due to increased local water temperatures observed in recent years from ocean circulation and climate changes.

Jellyfish can comprise a large component of the pelagic community biomass in Puget Sound and Elliott Bay during spring months (Rice 2007). Their abundance varies by location and year, is strongly influenced by latitude and date, and has been shown to be inversely related to biomass and diversity of the pelagic fish community (Rice 2007). Prominent jellyfish species common in Puget Sound include the crystal jelly (*Aequorea victoria*), moon jelly (*Aurelia labiata*), lion's mane jelly (*Cyanea capillata*) and fried egg jelly (*Phacellophora camtschatica*) (Harvey et al. 2010). These species appear to be more tolerant to low-oxygen conditions than many other related species (Rutherford and Thuesen 2005) and most common locally during spring (Anchor QEA 2012). Zooplankton, particularly copepods, are a major prey source for these species (Wrobel and Mills 1998; Purcell 2009). Some species have symbiotic relationships with macrozooplankton (e.g., pelagic amphipods) (Wrobel and Mills 1998). The seasonal aspect of jellyfish abundance in Puget Sound (Rice 2007) and the inherent difficulty of quantitatively sampling these fragile animals makes demographic assessment problematic, resulting in a limited understanding of their movements in the study area (Harvey et al. 2010).

4.3.2.2 Benthic Invertebrates

Benthic invertebrates occur on or in the ocean bottom or associated substrate and are common throughout the study area. At least 28 species of benthic invertebrates are known to occur in the study area (USACE 2008; SDOT 2011) (Figure 4-3). One species ubiquitous to most substrates in the nearshore is the acorn barnacle (*Balanus glandula*), comprising a majority of the coverage of the invertebrate species composition in this area (USACE 2008; SDOT 2011). Individuals of various sizes are found blanketing the entire intertidal zone (USACE 2008). Another barnacle that occurs less frequently despite being closely associated to nearshore rocky habitat is the little brown barnacle (*Chthamalus dalli)* (Kozloff 1993; USACE 2008; Harvey et al. 2010). Gastropods such as the Pacific blue mussel (*Mytilus edulis*) and black turban snail (*Tegula funebralis*) are commonly associated with pilings and other constructed surfaces in the study area (USACE 2008; Harvey et al. 2010; SDOT 2011). Frosted nudibranch (*Dirona albolineata*) and jingleshell oyster (*Pododesmus cepio*) are both mollusks common to the nearshore (SDOT 2011).

North of Pier 55, the diversity of marine invertebrates increases and species absent in the southern end of the study area begin to appear. Species such as ochre starfish (*Pisaster ochraceus*), sea snails (*Littorina* sp.), mask limpets (*Notoacmaea persona*) and giant green anemones (*Anthoplura xanthogrammica*) are present in low densities in this area (USACE 2008; Harvey et al. 2010; City of Seattle 2010b). Two species of sponges—*Haliclona* sp. and *Halichondria bowerbanki*—are also present in very low densities (USACE 2008; Harvey et al. 2010; City of Seattle 2010b). Hairy crabs (*Telmessus cheiragonus*), coonstripe shrimp (*Pandalus hypsinotus*), and Pacific octopus (*Enteroctopus dofleini*) are often present around Pier 59 (City of Seattle 2006, 2010b; USACE 2008). Species of echinoderms such as sunflower star (*Pycnopodia helianthoides*), bat star (*Patiria miniata*), and Pacific henricia (*Henricia leviuscula*) are present in protected areas such as Bell Street Marina, near Pier 66.

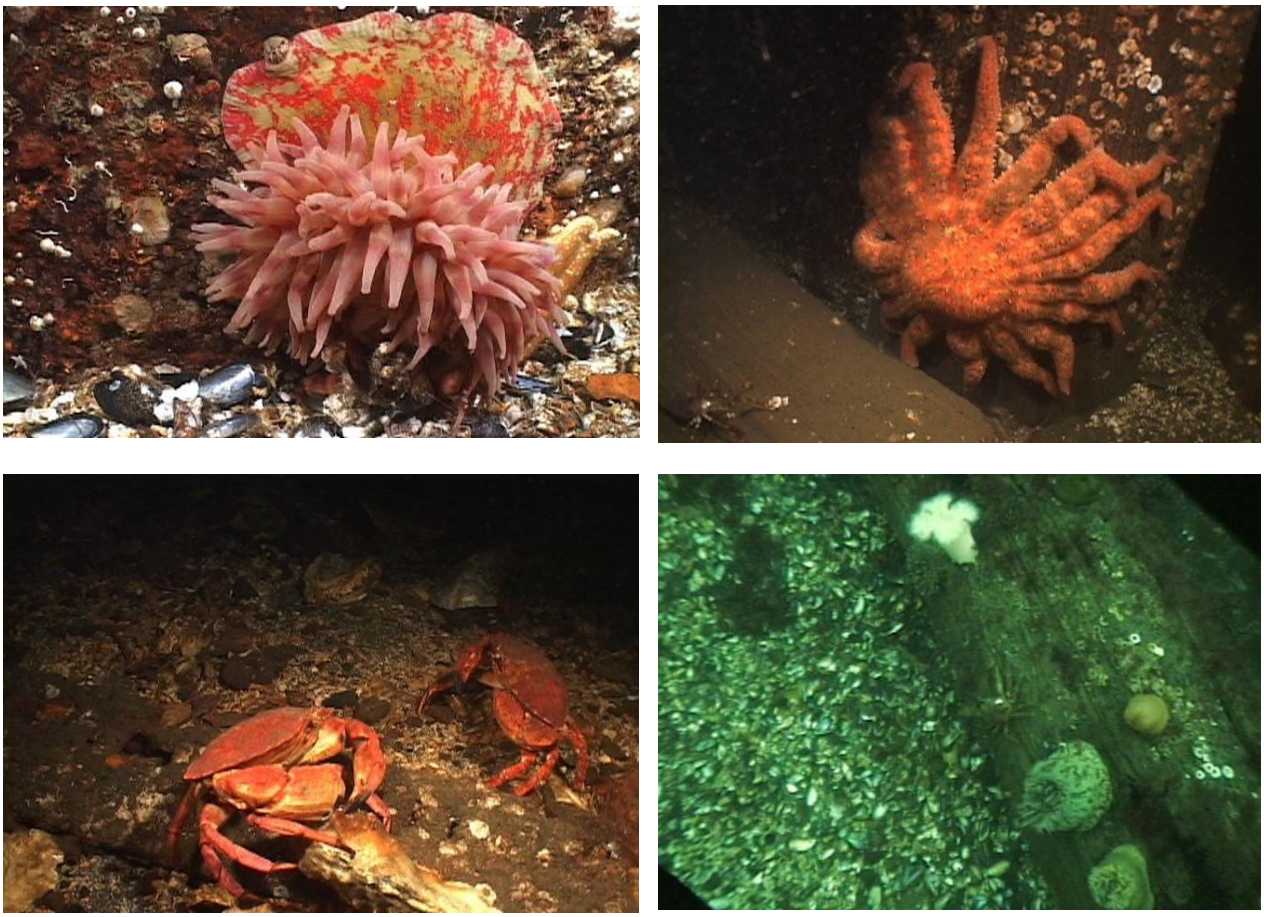


Figure 4-3. Benthic Invertebrates Found in the Study Area
(photo source: SDOT 2011)

Occasionally, Dungeness crab (*Cancer magister*), spider crab (Majidae), shore crab (*Hemigrapsus* sp.) and helmet crab (Cheiragonidae) are also found in this area (WSDOT 2004; Toft and Cordell 2006; USACE 2008; City of Seattle 2010b). Giant Pacific octopus (*Octopus dofleini*), a significant predator of many other invertebrates and fish, is also present throughout the nearshore (City of Seattle 2010b).

Non-rocky substrate such as pilings and other structural components associated with docks and piers host most of the same species found on other substrates; however, densities of species differ. Blue mussels and acorn barnacles dominate these areas while giant green anemones, ochre starfish, black turban snails and mask limpets are present at relatively lower densities (USACE 2008). Three patterns of distribution have been noted in the nearshore: the highest densities of invertebrates are associated with surfaces facing away from wave action, substrates composed only of steel host low densities of invertebrates, and few to no invertebrates are found under overwater structures (USACE 2008; City of Seattle 2010b). Only two species were observed on steel structures: Pacific blue mussels and giant acorn barnacles, which were both present in substantially lower densities relative to other substrates. Survey results for this proposed project have clearly shown that few organisms such as benthic invertebrates are present under piers and other overwater structures (SDOT 2011, Anchor QEA 2010); however limited transition zones may be present where they interface with open water.

Various non-native invertebrates have been reported to also reside in the nearshore of the study area. These include club tunicate (*Styela clava*), Manila clam (*Venerupis philippinarum*), European green crab (*Carcinus maenas*), freshwater hydroid (*Cordylophora caspia*), mud snail (*Batillaria attramentaria*), slipper limpet (*Crepidula fornicate*), mouse-ear marshsnail (*Myosotella myosotis*), giant oyster (*Crassostrea gigas*), blue mussel (*Mytilus galloprovincialis*), soft-shelled clam (*Mya arenaria*), and purple varnish clam (*Nuttallia obscurata*) (Kozloff 1993; KCEL 1998; Cohen et al. 2001; USACE 2008). Two species of sea squirts; *Didemnum vexillum* and *Ciona savignyi* are also present in the area (USGS 2011b) and could or have already moved into the study area. Impacts these species are having on the native assemblages is currently under investigation; however it is unclear when further information will be available.

The adjacent nearshore found north of Pier 66 has a higher diversity and density of invertebrates than areas to the south, and the areas between Pier 70 and Pier 86, adjacent to Olympic Sculpture Park and Myrtle Edwards Park, have the highest densities along the Seattle Waterfront (USACE 2008; City of Seattle 2010b). In the past, some species such as kelp crab (Epialtidae) and red rock crab (*Cancer productus*) were only noted in this area (USACE 2008), although they have been recently seen throughout the proposed project area (Anchor QEA 2012). Other species such as ocher starfish and bat star that are present throughout the study area had the highest densities in this area (USACE 2008).

4.3.2.3 Terrestrial Invertebrates

Terrestrial insects are an important prey component for many insectivores in the nearshore, including salmonids and various crab species (Wipfli 1997; Sobocinski et al. 2010; Duffy et al. 2010). Although little is known about the assemblage of insects in the study area, species known to be present include spiders (arachnida), dipteran flies (chironomidae), springtails (Collembola), bark lice (psocoptera), aphids (homoptera), ants (hymenoptera) and mites (acarina) (Toft et al. 2004; Toft et al. 2007; Sobocinski et al. 2010; Burke Museum 2011). It has been shown that densities of terrestrial insects in the nearshore are at their lowest where overhanging terrestrial vegetation has been replaced by constructed structures (Toft et al. 2004; Higgins et al. 2005; Sobocinski et al. 2010). Because minimal vegetation is present along the entire length of the seawall, it is assumed that densities of terrestrial insects are likely low. It is unclear how current densities compare to those prior to the construction of the seawall; however, it is assumed that the more natural shoreline vegetation found in Myrtle Edwards Park to the north of the study area has greater densities of terrestrial insects.

4.3.3 Fish

All marine waters of the EBSP study area provide habitat for various fish species. Included are species of skates, rays and sharks (chondrichthyes), lamprey (*Lampetra* sp.), salmon and trout (salmonidae), perch and gunnels (perciformes), herring and anchovies (clupeiformes), sandlance (ammodytidae), sculpin, lingcod and rockfish (scorpaeniformes), clingfishes (gobiesocidae), pricklebacks (stichaeidae), and flatfishes, flounders and soles (pleuronectiformes) (a species list is provided in Appendix A). Fishes in general are very important to many aspects of the local ecosystem and to the local economy for sport and as a food resource. The degraded habitat in the study area, among other pressures, contributes to a reduction in localized density in some species and may contribute to reduced individual viability. Several

fish species and associated habitats that occur in the study area have been listed as sensitive under the federal ESA, WDFW PHS program, or both. Nearshore habitat in the study area is included in designated Critical Habitat for selected ESA-listed species. These species will be fully discussed in Section 4.3.7, Threatened, Endangered, and Candidate Species.

In general, fish resources in the study area include marine species that are resident in Elliott Bay and anadromous salmonids that pass along the shorelines as juveniles and potentially as adults. Using these categories, the demographics of common and non-listed species that occur in the study area are discussed below.

To date, several field surveys of fishes have been performed in the nearshore of Elliott Bay (Matsuda et al. 1968; DeLacey et al. 1972; Weitkamp and Ruggerone 2000; Anchor Environmental 2002; Toft et al. 2004; Toft and Cordell 2006; WSDOT 2006; Toft et al. 2007; Toft et al. 2008; Toft et al. 2009; Toft et al. 2010), including two for this report (SDOT 2011; Anchor QEA 2012; Toft et al. 2012a, 2012b). Collectively, the results from these surveys provide the basis for qualitative comparisons of fish assemblages in the study area through time and across space. However, because surveys performed for this study are ongoing and have specifically targeted the study area, as information becomes available, they will be used as additional primary sources to describe existing conditions.

The surveys collectively illustrate some general patterns in fish demographics and distributions in the study area. Overall fish assemblages tend to differ between shallow and deep water: average fish densities are generally highest in deep water and associated to riprap, although high densities of a few species may drive this pattern. Also, water column position and behavior appears to vary by species. For salmonids, water-column position usually ranges from the middle to the surface and most other fishes occur at middle to bottom depths (Toft and Cordell 2006). One substantial behavioral pattern noted in the study area is the lack of fish in areas shaded by overwater structures. The surveys have shown biodiversity to be substantially lower in areas below piers compared to areas without overwater structures (SDOT 2011; Anchor QEA 2012). This pattern extends beyond resident marine plants and invertebrates to fishes, including migrants such as salmonids. It is known that areas with strong light contrast, such as where shadows are cast into nearshore waters from an overwater structure on a sunny day, provide barriers to juvenile salmon movement (Heiser and Finn 1970; Weitkamp 1982, 1993; Pentec Environmental 1997; Nightingale and Simenstad 2001) by causing altered migration patterns and likely increasing stress levels and exposure to predators. Observations of salmonid behavior in 2011 indicated that no juvenile salmon entered dark areas under piers at any time (Anchor QEA 2012). Monitoring in 2012 showed that some juvenile pink salmon swim at least a short distance under the piers, but it is not clear that they pass all the way underneath the structures (Toft et al. 2012a, 2012b).

4.3.3.1 Resident Marine/Estuarine Fish

Results from various surveys have shown the fish assemblage in the nearshore of the study area to have a diversity of resident species. Across all habitats, the most commonly observed species include shiner perch (*Cymatogaster aggregata*), pile perch (*Rhacochilus vacca*), striped seaperch (*Embiotoca lateralis*), tube-snout (*Aulorhynchus flavidus*), kelp perch (*Brachyistius frenatus*), brown rockfish (*Sebastes auriculatus*) and spotted ratfish (*Hydrolagus colliei*) (SDOT 2011; Anchor QEA 2012) (Figure 4-4). Other

common species are found in specific areas or zones of the marine environment. Species common to the demersal zone (area of water column adjacent to seabed) include Dover sole (*Microstomus pacificus*), English sole (*Parophrys vetulus*), kelp greenling (*Hexagrammos decagrammus*), Pacific tomcod (*Microgadus proximus*), blackbelly eelpout (*Lycodopsis pacifica*), bay pipefish (*Syngnathus leptorhynchus*), quillback rockfish (*Sebastes maliger*), copper rockfish (*Sebastes caurinus*) and Pacific staghorn sculpin (*Leptocottus armatus*) (SDOT 2011; Anchor QEA 2012). Species common to the benthopelagic zone (area ranging from the benthos to below surface waters) include spiny dogfish (*Squalus acanthias*), walleye pollock (*Theragra chalcogramma*), snake prickleback (*Lumpenus sagitta*), Pacific sand lance (*Ammodytes hexapterus*), lingcod (*Ophiodon elongates*), yellowtail rockfish (*Sebastes flavidus*), black rockfish (*Sebastes melanops*), Pacific hake (*Merluccius productus*) and surf smelt (*Hypomesus pretiosus*) (Matsuda et al. 1968; DeLacey et al. 1972; Weitkamp and Ruggerone 2000; Anchor Environmental 2002; WSDOT 2006; Toft et al. 2010; SDOT 2011; Anchor QEA 2012).

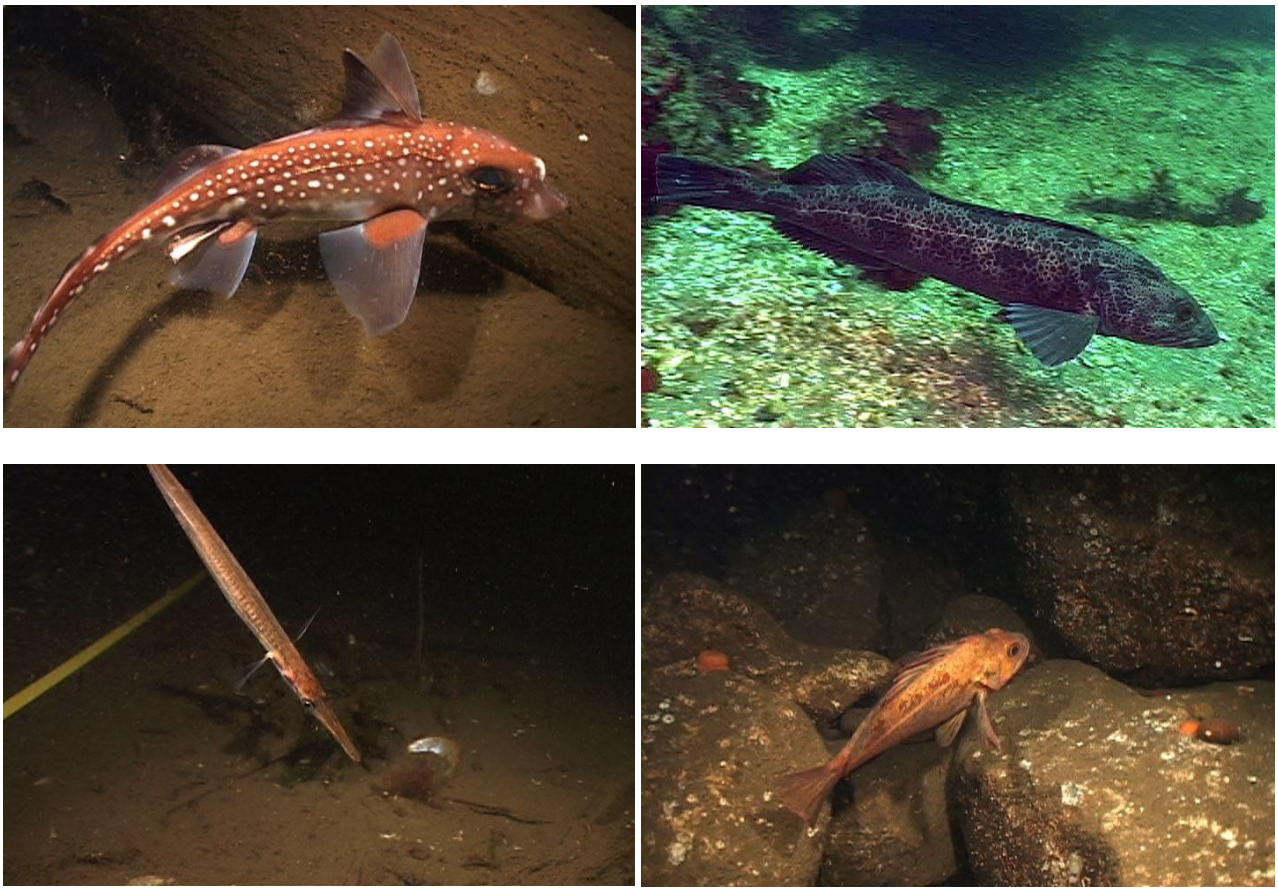


Figure 4-4. Fishes Found in the Study Area;
species shown clockwise from top left; spotted ratfish, lingcod, brown rockfish, and tube-snout
(photo source: SDOT 2011)

Seasonal patterns in the resident fish assemblages presumably occur to some extent in the nearshore. Although common, Pacific sand lance, surf smelt and Pacific herring tend to be present in high densities only during the summer months (Anchor QEA 2012). Likewise, larvae of some species are most

abundant during the summer months (SDOT 2011; Anchor QEA 2012). Densities of predatory species that prey on species with seasonal demographic patterns are likely to also fluctuate by season. Examples of some of these species may include bay pipefish, kelp perch, lingcod, ratfish, various sculpin and tube-snout. Little is known about the reproduction of these fish in the study area; however, tube-snout have been observed spawning on algae in the nearshore throughout the spring (Anchor QEA 2012).

Some resident or estuarine fish have been provided formal protection under the federal ESA or by the WDFW PHS program; these species will be discussed in Section 4.3.7, Threatened, Endangered, and Candidate Species. Habitat for Pacific Coast groundfish is formally protected under the Pacific Coast groundfish essential fish habitat (EFH) and will be discussed in Section 4.3.8, Essential Fish Habitat.

4.3.3.2 Anadromous Salmonids

At least nine species of native anadromous salmonids are known to occur in the study area and potentially frequent the nearshore and offshore waters as juveniles and adults. These species include Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), bull trout (*Salvelinus confluentus*), Dolly Varden (*S. malma*) and sea-run coastal cutthroat trout (*Salmo clarki clarki*) (Matsuda et al. 1968; DeLacey et al. 1972; Groot and Margolis 1991; Weitkamp and Ruggerone 2000; Anchor Environmental 2002; Toft et al. 2004; WSDOT 2004; Brennan et al. 2004; Toft and Cordell 2006; Fresh 2006; WSDOT 2006; Toft et al. 2010; SDOT 2011; Anchor QEA 2012; Toft et al. 2012a, 2012b). The close proximity of the study area to the Duwamish Estuary and other stream systems (see Foerster 1972; Williams et al. 1975; Weitkamp and Ruggerone 2000; WDOT 2004) causes the nearshore and offshore waters to be a necessary migration corridor and could serve as a rearing area. Spawning adults returning from the ocean migrate through Elliott Bay and along the Seattle waterfront (WDOT 2004). Juveniles move from spawning and rearing areas in the Green River into the Duwamish Estuary and out through the study area during outmigration. Adults and juveniles from other basins such as Lake Washington/Cedar River, Puyallup River, and Snohomish River, likely also use Elliott Bay and the study area (Brennan et al. 2004). Up until recently, a quantitative understanding of the demographics of salmonids in the study area was incomplete and lacking. However, recent surveys by Anchor QEA (SDOT 2011; Anchor QEA 2012) have provided supplemental data on distributions, timing, as well as species and age assemblages of salmonids in the study area. These surveys are currently ongoing and will provide additional information that will be incorporated into future reports.

Salmonids use the waters of the study area during transient phases of their life cycles, causing each to be present at different times and virtually ensuring that at least one species can be found in the nearshore at all times of the year (Brennan et al. 2004). Juveniles typically rear and migrate through the study area during spring and summer (City of Seattle 2006), although juvenile Chinook salmon have been observed to be present in Elliott Bay as early as January (Nelson et al. 2004) and in the nearshore as late as October (Brennan et al. 2004). Juvenile coho are generally present in mid-February to mid-June with some remaining until October (Warner and Fritz 1995; Brennan et al. 2004). Adults also vary in their timing in the nearshore, causing adults of at least one species to be present at most times of the year. For example, adult Chinook migrate along the Seattle shoreline from late June through mid-November, peaking between late September and late October (Grette and Salo 1986; Williams et al.

2001). In contrast, adult coho are present from early August to late January (Taylor Associates 1995; Warner and Fritz 1995). This complex temporal pattern of when juveniles and adults of each species can be found in the nearshore of the study area is illustrated in Table 4-1.

TABLE 4-1. APPROXIMATE SALMONID SEASONAL TIMING IN THE WATERS OF ELLIOTT BAY, INCLUDING THE STUDY AREA

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Chinook												
Coho												
Chum												
Pink												
Sockeye												
Steelhead												
Sea-run cutthroat												
Bull trout												

Legend: Juveniles Adults Adults and Juveniles

Sources: Grette and Salo 1986; SDOT 2011; Anchor QEA 2012; and current demographic data from state and federal agencies.

Spatially, salmonids maintain somewhat predictable distributions in the study area but vary across life stages. Juvenile salmonids are generally more abundant in the shallow waters of the nearshore but increase in densities during periods of high tide; which differs from adults who prefer areas upwards from the middle of the water column (Toft and Cordell 2006). As a group, juveniles have been shown to have some of the highest densities in the surface waters near the seawall during the spring and early summer (City of Seattle 2006; WSDOT 2006; Anchor QEA 2012). In contrast, adult Chinook are found in the middle of the water column or near the surface while adult chum tend to stay only near the surface (Toft and Cordell 2006). Salmonids in the study area have been shown to usually avoid waters underneath overwater structures (Toft et al. 2004, 2012a, 2012b; Anchor QEA 2012); however, they do school near piling edges at the shade line, as well as in open, non-shaded water, and under particularly low-light conditions, show little preference between non-shaded and shaded areas but tend to avoid areas under overwater structures (WSDOT 2006; Anchor QEA 2011b). The existing sidewalk along the seawall is cantilevered over the water, but no evidence shows that significant shading has occurred or that salmon behavior has been affected (Anchor QEA 2012). The highest densities of Chinook and coho salmon appear to be associated with areas of shallow riprap (Heiser and Finn 1970; Weitkamp 1982, 1993; Pentec Environmental 1997; Nightingale and Simenstad 2001; Toft et al. 2004; WSDOT 2006; Toft and Cordell 2006; Anchor QEA 2011b). Little is known about the migratory habits of bull trout or Dolly Varden in Elliott Bay. There have been infrequent and isolated observations of bull trout in Elliott Bay suggesting they could occur in the nearshore of the study area (City of Seattle 2006).

Juvenile salmon feed in all habitats that they occupy and use prey that originate from a wide diversity of sources including pelagic, benthic, and terrestrial sources (Fresh et al. 1981; Healey 1982; Simenstad et al. 1982; Brennan et al. 2004; Duffy et al. 2005). This relatively abundant and diverse prey base helps maintain high growth rates during use of the nearshore (Simenstad et al. 1982). Biological processes that support the prey base are a complex series of interactions that involve the acquisition, processing, and conversion of organic matter and nutrients used to nourish prey species. Nearshore food webs are of particular importance because they support relatively high densities of various prey types that are essential to small juvenile salmon and because they depend upon internally derived (i.e., from nearshore habitats) sources of organic matter such as from eelgrass or riparian plant species (Sibert et al. 1977). A variety of factors affect feeding and growth of salmonids including habitat characteristics, fish size, temperature, turbidity, tidal convergence zones, time of year and climate (Simenstad et al. 1980; Fresh et al. 1981; Gregory 1994).

Salmonids face a wide variety of predators such as fish, birds, and mammals during their nearshore residence (Parker 1971; Fresh 1997). To escape this pressure, Simenstad et al. (1982) suggested juvenile salmonids may seek shelter in some features of the nearshore ecosystem. Such features include areas of high turbidity (Gregory 1993; Gregory and Levings 1998), presence of shallow water habitat, and abundant and diverse prey resources that would sustain high growth rates in juvenile salmonids and allow them to rapidly outgrow many of their predators (Simenstad et al. 1982).

In general, our ability to quantitatively or conceptually link nearshore habitat characteristics to functions of that habitat for juvenile salmon (i.e., salmon performance) varies considerably with species and habitat type. This in part reflects the complexity of the salmon life cycle and the fact that the habitat requirements of salmon can vary widely as a function of many factors including specific location of that habitat, time of year, species, population, size of an individual, and life history strategy. This differs from many other nearshore species that have fairly specific habitat requirements. Studies of migrating juvenile chum salmon in Hood Canal have provided insight on the link between the nearshore and prey (Salo et al. 1980; Bax 1983). Strong linkages between juvenile chum salmon and specific prey communities associated with particular types of littoral habitats such as eelgrass beds are only found in the nearshore (Simenstad and Wissmar 1985; Simenstad et al. 1988). As a result, the distribution and landscape configuration of eelgrass may have an important influence on performance of chum salmon fry. In addition, juvenile chum salmon, like juvenile Chinook salmon, make extensive use of non-natal deltas for growth and development (Bax 1983).

Each salmonid employs a fundamentally different approach in how it uses freshwater, marine and nearshore landscapes. For example, juvenile sockeye salmon rear extensively in lakes, coho rear for at least one year in streams, and pink and chum salmon do not rear in freshwater. While species-specific differences in salmon habitat use have long been appreciated, our understanding of the significance of variability in habitat use at other scales (e.g., within a species) is more recent and in the early stages of research.

During their residence in estuaries and the marine nearshore, the survival of juvenile salmon reflects the ability of the habitat to support four main ecological functions (summarized in Anchor QEA 2011b): foraging and growth, avoidance of predators, physiological transition, and migration to the ocean. These

ecological functions are highly interrelated. For example, the growth of juvenile salmon depends in part upon the energy demands and foregone foraging opportunities that result from predator avoidance actions (Anchor QEA 2011b). The importance of juvenile salmon access to high quality marine nearshore habitat that supports each of these ecological functions is becoming increasingly apparent in investigations of salmon survival in the marine environment (Duffy 2003; summarized in Anchor QEA 2011b).

The study area and surrounding landscape has been substantially altered from historic conditions, fundamentally degrading the local environment for all salmonid species. Pier construction has caused large portions of the nearshore to be shaded and dark regardless of time of day. In addition, the nearshore areas close to the seawall host little intertidal habitat and depths are generally 10 to 30 feet within 50 linear feet of the seawall. Furthermore, the shallowest areas tend to be found under piers where little or no daylight penetrates into the nearshore. The only habitat found waterward of the seawall that is higher than mean lower low water is restricted to Zone 1 north of Pier 48 and within the Bell Harbor Marina in Zone 5. In addition, no backshore marsh or riparian vegetation is present along the seawall other than the occasional street tree. The modifications that have taken place in the project area have primarily occurred along the nearshore corridor that juvenile salmon rely upon during their critical early marine life stage. Additional pressures from reduced water quality also likely stress salmonids in the area. Salmonids are also known to be sensitive to various anthropogenic stressors. Juveniles are particularly sensitive to habitat modification and disturbance from underwater noise such as pile driving (Feist 1991; Vagle 2003; Nedwell et al. 2006; Ruggerone et al. 2008). Additional stressors exist in other habitats outside of the study area and include fishing pressures, fish passage barriers, habitat degradation in spawning streams and migration corridors (including the near total elimination of the Duwamish Estuary), and environmental pressures in the open ocean.

To some extent, all locally occurring salmonid populations have dwindled due to anthropogenic pressures. Habitat utilization in the Puget Sound region has been dramatically reduced by large dams and other manmade barriers in a number of drainages. In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Many upper tributaries in the Puget Sound region have been affected by poor forestry practices, while many of the lower reaches of rivers and their tributaries have been altered by agriculture and urban development. Urbanization has caused direct loss of riparian vegetation and soils, substantially altered hydrologic and erosional rates and processes (e.g., by creating impermeable surfaces such as roads, buildings, parking lots, sidewalks, etc.), and polluted waterways with stormwater and point-source discharges. The loss of wetland and riparian habitat has dramatically changed the hydrology of many streams, with increases in flood frequency and peak flow during storm events and decreases in groundwater driven summer flows (Moscrip and Montgomery 1997; Booth et al. 2002). Estuarine areas located at the interface between rivers and Puget Sound have been extensively dredged and filled, resulting in the loss of important juvenile rearing habitat. In addition to being a factor that contributed to the present decline of Puget Sound salmonid populations, the continued destruction and modification of essential habitat features is the principal factor limiting the viability of these species into the foreseeable future.

Some of the salmon species present in the study area have been listed under the federal ESA or WDFW PHS program as species of special concern; these species will be discussed in detail in Section 4.3.7, Threatened, Endangered, and Candidate Species section. Formal protection for salmonid habitat as salmon EFH has been designated for all species that occur in the study area; some species also have designated critical habitat. A full discussion of salmon EFH is provided in Section 4.3.8, Essential Fish Habitat.

4.3.4 Wildlife

Wildlife in the study area is composed primarily of species well adapted to living in a highly altered urban landscape as well as seasonal use by marine birds. Examples include invertebrates, birds, and mammals that tolerate, and in some cases, benefit from human disturbance, urban habitat features, and refuse. Common pelagic, benthic, and terrestrial invertebrates are discussed under Section 4.3.2, Invertebrates. Few if any reptiles are present in the study area and potentially occurring species would be very uncommon. Common wildlife species found or potentially occurring in the study area are listed and discussed below.

4.3.4.1 Birds

Many species of birds use the study area at least during part of the year. This species assemblage includes a somewhat diverse mix of waterbirds, waterfowl, seabirds, waders, passerines, shorebirds, and raptors. In general, this assemblage can be broken into two groups; those associated to the nearshore environment and those associated to the surrounding upland. Several birds have been listed as species of concern by federal and state agencies. These species will be discussed at length in Section 4.3.7, Threatened, Endangered, and Candidate Species. Protection has been afforded to all birds under the Migratory Bird Treaty Act (16 U.S.C. 703-712), which states that all migratory birds and their parts (including eggs, nests, and feathers) are fully protected. Bald eagles receive additional protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), which protects the bald and golden eagle by prohibiting, except under certain specified conditions, “take,” possession, and commerce of such birds.

4.3.4.1.1 Nearshore Birds

In the study area, nearshore bird species composition and density varies by season; however, a few species do occur in the area year-round. Some of the most common species include gulls such as herring gulls (*Larus argentatus*), California gulls (*L. californicus*) and ring-billed gulls (*L. delawarensis*) (Eissinger 2007; USACE 2008; Audubon 2011). These species are usually found perched on piers or floating on the water surface. Other common species that often swim on the water surface or dive offshore include double-crested cormorant (*Phalacrocorax auritus*), pigeon guillemot (*Cepphus columba*), common goldeneye (*Bucephala clangula*), surf scoter (*Melanitta perspicillata*), common merganser (*Mergus merganser*) and western grebe (*Aechmophorus occidentalis*) (USACE 2008; Audubon 2011). Wading birds and shorebirds also occasionally use the study area; some of the most common are killdeer (*Charadrius vociferus*) and great blue heron (*Ardea herodias*), which are usually seen foraging along exposed shoreline (USACE 2008; Audubon 2011). Belted kingfisher (*Ceryle alcyon*), a passerine-like bird

in the family coraciiformes, commonly hunt for fish along the waterfront (USACE 2008; Audubon 2011; Anchor QEA 2012).

Winter at Elliott Bay typically hosts the highest numbers of waterbirds with total densities often ranging from 125 to 250 individuals per square mile in some areas (Nysewander et al. 2005; USACE 2008). Such densities are attributed to a large influx of migrants that seek shelter and feeding grounds in the mostly protected waters of Elliott Bay (USACE 2008). Some species regularly seen in the study area during the winter season include red-necked grebe (*Podiceps grisegena*), lesser scaup (*Aythya affinis*), American wigeon (*Anas americana*), hooded merganser (*Lyphodytes cucullatus*), glaucus gull (*Larus hyperboreus*), glaucous-winged gull (*L. glaucescens*), pigeon guillemot (*Cepphus columba*), common murre (*Uria aalge*), rhinoceros auklet (*Cerorhinca monocerata*) and Canada goose (*Branta canadensis*) (USACE 2008; Audubon 2011).

4.3.4.1.2 Upland Birds

Some of the most common upland bird species in the study area are exotics such as house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), and rock pigeon (*Columba livia*) which are ubiquitous throughout the waterfront (USACE 2008; Audubon 2011). Some native species are also common including American crow (*Corvus brachyrhynchos*), Northwestern crow (*Corax caurinus*) and Brewer's blackbird (*Euphagus cyanocephalus*). Black-capped chickadee's (*Parus atricapillus*), another native species, commonly nests in ornamental trees planted along Alaskan Way and in Myrtle Edwards Park (WSDOT 2004; USACE 2008; Audubon 2011). Purple martin (*Progne subis*) and violet-green swallow (*Tachycineta thalassina*) also nest in the area, although they typically rely on artificial nest structures or cavities in buildings (USACE 2008; Audubon 2011).

Four raptor species are seen periodically in the study area: bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), osprey (*Pandion haliaetus*) and red-tailed hawk (*Buteo jamaicensis*) (USACE 2008; Audubon 2011). The relative infrequency of sightings is attributed to these species only using the study area for hunting (WSDOT 2004; Buchanan 2006; USFWS 2007; WDFW 2011). While bald eagles and osprey both require large natural structures near water to construct nests—habitat features that have been all but removed from the area as the result of urbanization—peregrine falcons tend to nest in upland areas on tall anthropogenic structures such as high-rise buildings and towers (WDFW 2007; FRG 2011; WDFW 2011, 2012). Red-tailed hawks are the most infrequent raptor in the study area (USFWS 2007); their low frequency is due to their requirement for open terrestrial areas with natural substrate for hunting. Similar to peregrine falcons, red-tailed hawks have been documented nesting on various structures around Elliott Bay (WDFW 2007).

4.3.4.2 Mammals

Various mammals utilize the highly altered urbanized habitats in the study area. Similar to birds, the assemblage of mammals can be broken into two groups: those associated to the marine environment and those associated to the surrounding upland. In general, mammals of the marine environment are native species while those who occupy upland areas are of exotic origin. Several marine mammals have been listed as species of concern by federal and state agencies. These species will be discussed at length in Section 4.3.7, Threatened, Endangered, and Candidate Species. Marine mammals are afforded

protection under the MMPA (16 U.S.C. 1361), which prohibits "take" of all marine mammals unless under special circumstances.

4.3.4.2.1 Marine and aquatic mammals

Various marine and aquatic mammals including cetaceans, pinnipeds, and one species of mustellid are known to utilize Elliott Bay and the waters of the study area. Cetaceans such as killer whale (*Orcinus orca*), Dall's porpoise (*Phocoenoides dalli*) (Osborne et al. 1988), harbor porpoise (*Phocoena phocoena*) (NOAA 1995) and gray whale (*Eschrichtius robustus*) (Glover 1999; NOAA 1993) are seen at times in the offshore waters of Elliott Bay. Of these species, gray whale sightings are the most infrequent, occurring primarily between March and May during their northward migration with some whales possibly using the greater Puget Sound as a summering ground (Osborne et al. 1988; NOAA 1993). Pinnipeds such as harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californicus*) are common and occur in the nearshore of Puget Sound, and more specifically around piers near the seawall and Olympic Sculpture Park (Gretchen and Calambokidis 1986; Osborne et al.1988; USACE 2008; Anchor QEA 2012) where they use intertidal benches, spits, bars, rocks and log rafts as haul outs to bask and sleep. Harbor seals are the only pinniped found in the waters of Washington State year round and are the only seal that breeds in the general area (Ross et al. 1998; USEPA 1999; Jeffries et al. 2000). Northern river otter (*Lontra canadensis*) are known to frequent many areas of nearshore in Elliott Bay (King County 1999) and are assumed to utilize the study area.

4.3.4.2.2 Upland mammals

Very few species of upland mammals are present within the urbanized and disturbed study area and of those, many are of exotic origin. Common species include non-native species such as the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*) and eastern gray squirrel (*Sciurus carolinensis*). Rats and mice may occur in buildings or in vegetated areas adjacent to the AWV or in Myrtle Edwards Park and Olympic Sculpture Park to the north of the study area. Areas of debris and voids in the pavement could be havens for these mammals, potentially offering high-quality feeding and/or residence sites that could concentrate these species in high densities. The eastern gray squirrel, an invasive species which has mostly replaced the native western gray squirrel (*Sciurus griseus*), inhabits treed parks and boulevards where it seeks cover and food (USACE 2008). Domesticated animals such as dogs and cats are likely to also be present as feral or human companion animals.

Native species that may occasionally be present in the study area include opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*) and coyote (*Canis latrans*). These species most likely frequent nearby parks but would also venture into more urbanized areas to seek food or for dispersal. Native bat species occasionally roost in buildings or other structures and forage in the study area. WSDOT (2004) identified eight species of bats that may occur in the area. The most common bats are big brown bats (*Eptesicus fuscus*) and those in the genus *Myotis*, with four species being identified as potentially occurring in the study area (WSDOT 2004). One other species that may occur in the study area, the Pacific Townsend's big-eared bat (*Corynorhinus townsendii*), is a species of concern in Washington State (USFWS 2010).

4.3.5 Climate Change

An important factor for understanding future trajectories of ecosystem health in Puget Sound and the study area is climate change and its subsequent impacts on the environment. Although some environmental shifts associated with climate change have been recently measured and quantified (i.e., increased ocean temperatures, increased glacial-sourced runoff, etc.), much of our current understanding comes from models providing predictions of environmental shifts. A series of key reports on localized impacts by climate change have highlighted major projected changes for the coastal-marine features of Puget Sound (Snover et. al. 2005; Curtiss 2006; Petersen 2007; Petersen et al. 2008; Huppert et al. 2009). These impacts include: increases in air and water temperature, alteration of river and stream flows with decreased snow pack, increased flooding from more rain and less snow, accelerated sea-level rise, changes in size and productivity of near-shore habitats (e.g., salt marshes, eelgrass beds, kelp communities), water flow and temperature impacts on salmon migration and spawning, and temperature shifts to the marine plankton trophic dynamics with linkages to invertebrates, fish, and marine mammals. Although the implications of these impacts are based heavily on predictions, conservative interpretations suggest substantial environmental changes will occur in Puget Sound and in the study area. These changes would likely have drastic impacts on all species and habitats in the area but would likely have the greatest impact on those that currently have depressed populations. A complete discussion on sea level rise and water quality changes resulting from climate change is presented in the Water Resources Discipline Report (SDOT 2012b).

4.3.6 Pollutants in the Nearshore

Water quality and sediment quality are known to be degraded in the study area compared to natural conditions (see the Water Resources, Geology and Soils, and Contaminated Materials Discipline Reports [SDOT 2012b, 2012c, 2012a, respectively] for detailed discussions) and are thought to have a deleterious impact on biological resources. Pollutants including various toxins or contaminants are from both current and past sources such as industrial activities and stormwater discharges and CSO events that continue to flow directly into the study area nearshore from the urban environment (a complete list of pollutants and contaminants is provided in the Water Resources Discipline Report [SDOT 2012b]). A wide range of pollutants are found in the water and sediments in the study area. Studies conducted by Ecology and others have detected high levels of various metals, chemical compounds, and bacteria in the nearshore (Romberg et al. 1985; Hart Crowser 1994; Michelsen et al. 1998; Puget Sound Partnership 2003; Ecology 2008). Common pollutants conveyed into the nearshore through stormwater outflow include benzo(a)pyrene, total and dissolved zinc, caffeine, lead, total and dissolved copper, and total suspended solids (a complete list is provided in the Water Resources Discipline Report [SDOT 2012b]). Three major stormwater outfalls are present at the ends of S. Washington Street, Seneca Street, and Pine Street (a total of six are found in the proposed project area), and four CSO outfalls are present at the ends of S. Washington Street, Madison Street, University Street, and Vine Street. Over time, it is likely that pollutants from the outfalls and historical industrial sources have accumulated in the nearshore environment where they have moved into local organisms and the food web and bioaccumulated in some consumers (i.e., mammals, birds, and fish). Exposure risk and the extent and types of impacts on local consumers are determined by their residence time, timing in the area, and

several aspects of their life history. Long residence time, utilizing the area when toxin concentrations are at their highest (i.e., during the rainy season, particularly during “first flush” in the fall), and being a top predator all contribute to the highest exposure risk. Many organisms residing in areas of the Puget Sound including the nearshore of the study area have been shown to have elevated levels of pollutants in their tissues. Although all species are susceptible to the accumulation of pollutants from environmental sources, residents or species that live their entire lives in Puget Sound have been shown to accumulate the highest concentrations. Long-lived residents in particular, often have the highest concentrations due to having the longest exposures times (Puget Sound Partnership 2005). Populations of Chinook salmon, which remain and feed in the nearshore environment as subadults and then migrate to the greater Puget Sound to mature, have average PCB (polychlorinated biphenyl) concentrations three to five times higher than those measured in other populations that reside out of the area in the Salish Sea (Donna et al. 2009; O'Neill and West 2009). Puget Sound herring have a similar pattern; they have three to nine times higher PCB concentration and 1.5 to 2.5 times higher DDT (dichloro-diphenyl-trichloroethane) concentration than Strait of Georgia herring (West et al. 2008). Early research on accumulated pollutants in sport fish residing in Central Puget Sound bays including Elliott Bay, showed species such as sablefish (*Anoplopoma fimbria*), Pacific cod, squid, and English sole to all have elevated levels of arsenic, cadmium, lead, and PCBs (Landolt et al. 1985; KCEL 1998). Effects of high concentrations of these pollutants can be difficult to quantify, but evidence has shown that fish become more susceptible to diseases; they can develop lesions or other abnormalities (approximately four percent of the individuals in the survey area [Anchor QEA 2012]), and suffer detrimental reproductive effects (Muirhead et al. 2006; Tomy et al. 2004; Arkoosh et al. 2010).

When species with accumulated toxins are consumed by larger predators, toxin concentrations can exponentially increase through the process of biomagnification. Marine mammals such as sea lions, seals, and killer whales as well as birds such as osprey and bald eagles, are all known to have very high tissue pollutant concentrations due to this phenomenon (Ross 2006; USFWS 2007; WDFW 2006; USFWS 2007; NMFS 2008; Henny et al. 2009). As with fish, the effects of high pollutant concentrations on marine mammals and birds is often difficult to quantify; however, recent research has shown substantial patterns. Captive harbor seals fed a diet from an area contaminated with PBDEs (polybrominated diphenyl ethers) and PCBs suffered detrimental effects on their reproductive and immune systems and reduced thyroid function (Ross 2006). Although the physical effects that pollutant loading have on killer whales are not clear, it is known that their field-measured PCB concentrations have proven to be higher than those of the captive harbor seals (Ross 2006). One hypothesis for how PBDEs and PCBs have impacted southern resident killer whales was through observations made in the 1990s. A substantial population decline of 20 percent occurred between 1996 and 2001. Mortality rates were highest in juveniles, adult males, and post-reproductive females; the same whales that have the highest toxic bodily burdens. It is hypothesized that a decline in Chinook salmon in the 1990s stressed the killer whales into using their fat stores (where most persistent toxins are stored) and thereby increasing the contaminant load circulating in their blood, suppressing their immune function and making them more vulnerable to disease and mortality (Krahn et al. 2009). Across all marine mammals, it is generally assumed that high concentrations of pollutants (i.e., PCBs, DDT, and PBDEs) that persist in the study area are likely to cause maladaptive physiological changes such as compromised immune and

reproductive systems that lead to reduced fecundity and increased mortality rates (NOAA 1993; USEPA 1999; Cullon et al. 2001; Lambourn et al. 2001; NMFS 2008). High concentrations of pollutants in raptors such as osprey have shown similar physical effects and are thought to ultimately cause reduced reproductive success (USFWS 2007; Henny et al. 2009).

Various stressors are ubiquitous in natural marine ecosystems but increased intensity and prevalence of pollutants can substantially increase effects on salmonids. Pollution of the natural aquatic environment with industrial or agricultural sewage is an important immunosuppressor that results in higher susceptibility to infectious diseases (Kollner et al. 2002). For example, juvenile Chinook salmon exposed to PCBs and PAHs during outmigration through the Duwamish Waterway Estuary exhibited depressed immune function, making them susceptible to a marine pathogen, *Vibrio anguillarum* (Arkoosh and Collier 2002). This same pattern was also induced in the lab when the same species and age classes were exposed to PCBs and PAHs (Arkoosh and Collier 2002). Salmonids exposed to other pollutants have also developed health problems such as increased mortality rates, developmental problems, and increased rates of infections (Schmidt-Posthaus et al. 2001). Microbial diseases and parasite infections are common in fish living in coastal systems with high levels of chemical and sewage contamination (e.g., Kennish 1997). In addition, disease or parasitic infections can lower the resistance of organisms to other stressors (e.g., Brown and Pascoe 1989) further increasing adverse effects.

4.3.7 Threatened, Endangered, and Candidate Species

As stated in Section 3.3 of this Discipline Report, Section 7 of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of any threatened or endangered species or adversely modify their habitats. The ESA further requires the federal government to designate "critical habitat" for any species it lists under the ESA. Other federal protection laws potentially applicable to this Discipline Report are listed in Section 3.3 (this report).

Section 6 of the ESA provides a mechanism for cooperation between federal agencies and states in the conservation of threatened and endangered species. Species considered in this discussion will be those listed as "endangered," "threatened," or "candidate" by the federal agencies or as "endangered" or "threatened" by WDFW.

Table 4-2 lists 18 endangered, threatened, and candidate species with the potential to occur in King County; however, only some of these species have the potential to occur in the proposed action area. Ten federally listed species have been determined to have the potential to be in the proposed action area, two are endangered and eight are threatened (NOAA-NMFS 2009, 2010, 2012a, 2012b, 2012c; USFWS 2010). WDFW has identified two additional species through its PHS program that have the potential to occur in the proposed action area; both are listed as candidate species (WDFW 2008, 2011, 2012). Each of these species and any associated critical habitat are discussed in this section. Five other species listed by the federal agencies as occurring in King County do not occur in the proposed action area and will not be discussed in this section. These species include: Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos = U. a. horribilis*), northern spotted owl (*Strix occidentalis*

caurina), and the golden paintbrush (*Castilleja levisecta*). All species lists obtained for this document are presented in Appendix A.

TABLE 4-2. ENDANGERED, THREATENED, AND CANDIDATE SPECIES PRESENT IN AND AROUND THE ELLIOTT BAY SEAWALL PROJECT AREA (listing status and likelihood of occurrence in the study area are also presented)

Common Name (Scientific name)	Status (Federal/State)	Potential of Occurrence
Endangered		
Bocaccio (*Sebastes paucispinis*); Puget Sound DPS [4/7]	Endangered/Candidate	Unlikely
Leatherback sea turtle (*Dermochelys coriacea*) [3]	Endangered/None	Not present
Green sea turtle (*Chelonia mydas*) [3]	Endangered/None	Not present
Olive Ridley sea turtle (*Lepidochelys olivacea*) [3]	Endangered/None	Not present
Northern spotted owl (*Strix occidentalis caurina*) [1/7]	Endangered/Threatened	Not present
Southern resident killer whale (*Orcinus orca*) [5/7]	Endangered/Endangered	Likely
Humpback whale (*Megaptera novaeangliae*) [5/7]	Endangered/Endangered	Unlikely
Threatened		
Pacific eulachon (*Thaleichthys pacificus*); Southern DPS [6/7]	Threatened/Candidate	Unlikely
Bull trout (*Salvelinus confluentus*); Coastal-Puget Sound DPS [1/7]	Threatened/Candidate	Likely
Chinook salmon (*Oncorhynchus tshawytscha*); Puget Sound ESU [2/7]	Threatened/Candidate	Likely
Steelhead (*Oncorhynchus mykiss*); Puget Sound DPS [2/7]	Threatened/Candidate	Likely
Canary rockfish (*Sebastes pinniger*); Puget Sound DPS [4/7]	Threatened/Candidate	Unlikely
Yelloweye rockfish (*Sebastes ruberrimus*); Puget Sound DPS [4/7]	Threatened/Candidate	Unlikely
Loggerhead sea turtle (*Caretta caretta*) [3]	Threatened/None	Not present
Marbled murrelet (*Brachyramphus marmoratus*) [1/7]	Threatened/Threatened	Unlikely
Steller sea lion (*Eumetopias jubatus*); eastern DPS [5/7]	Threatened/Threatened	Unlikely
Candidate		
Coho salmon (*Oncorhynchus kisutch*); Puget Sound/Georgia Basin ESU [2/7]	Concern/Candidate	Likely
Chum salmon (*Oncorhynchus keta*); Puget Sound/Strait of Georgia ESU [7]	None/Candidate	Likely

Sources: [1] USFWS 2010, [2] NOAA-NMFS 2009, [3] NOAA-NMFS 2012a, [4] NOAA-NMFS 2012b, [5] NOAA-NMFS 2012c, [6] NOAA-NMFS 2010, [7] WDFW 2008, 2011

4.3.7.1 Bocaccio; Puget Sound DPS

Bocaccio (*Sebastes paucispinis*) Puget Sound DPS were listed as endangered under the ESA on April 28, 2010 (75 FR 22276), and a listing status of candidate has been applied by WDFW. No critical habitat has been designated for this species to date.

Bocaccio share many natural history traits with other rockfish including the federally and state-listed canary rockfish and yellow rockfish. Bocaccio are large, long-lived Pacific Coast rockfish that are suspected to live as long as 50 years (NMFS 2009; NOAA 2009). They occupy depths between 160 and 820 feet but may be found as deep as 1,560 feet (NMFS 2009; NOAA 2009). Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops (NMFS 2009; NOAA 2009). Juveniles and subadults may be more common than adults in shallower water and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and oil platforms. While generally associated with hard substrata, adults do wander into mud flats. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore (NMFS 2009; NOAA 2009). Larvae and small juvenile rockfish may remain in open waters for several months being passively dispersed by ocean currents (NMFS 2009; NOAA 2009). Bocaccio are fished directly and often captured as bycatch in other fisheries including those for salmon (NMFS 2009; NOAA 2009). Adverse environmental factors led to recruitment failures in the early- to mid-1990's resulting in the depressed population present today.

Bocaccio range from Punta Blanca, Baja California to the Gulf of Alaska off Krozoff and Kodiak Islands. They are most common between Oregon and northern Baja California. In a study on local recreational fishing, bocaccio were shown to have made up 89 percent of the Puget Sound recreational catch in the late 1970s (Palsson et al. 2009), with the majority of fish caught in the areas around Point Defiance and the Tacoma Narrows in the South Basin. Bocaccio have always been rare in the North Puget Sound surveys of the recreational fishery (Drake et al. 2010). In the Strait of Georgia, bocaccio have been documented in some inlets, but records are sparse, isolated, and often based on anecdotal reports (COSEWIC 2002). These patterns suggest bocaccio are unlikely to be present in the area of interest and supporting habitat features are uncommon or absent in the area.

4.3.7.2 Southern Resident Killer Whale

The southern resident killer whale (*Orcinus orca*) was listed as endangered under the federal ESA on November 18, 2005 (70 FR 69903), and a listing status of endangered has been applied by WDFW. Critical habitat, designated on November 29, 2006 (71 FR 69054), includes the waters greater than 20 feet deep in Elliott Bay.

The southern resident killer whale community is composed of three pods; J, K, and L pods, numbering upwards of 90 whales. They range in the inland waters of Puget Sound, Juan de Fuca Strait, and the Strait of Georgia during the spring, summer, and fall (NMFS 2008; Center for Whale Research 2011). Although relatively little is known about the winter movements and range of Southern Residents, they have been seen in coastal waters off of Oregon, Washington, Vancouver Island, central California and the Queen Charlotte Islands (NMFS 2008). The pods aggregate temporarily throughout the year and are often seen traveling and socializing together (Osborne et al. 1988; Osborne 1999; Ford et al. 2000; Kriete

2007; Center for Whale Research 2011). Breeding is assumed to also take place during these social encounters, although it has never reliably been observed in the wild.

Southern resident killer whales feed primarily on salmon and other fish species and are often found in and around Puget Sound during the summer and early fall pursuing migrating chum and Chinook salmon (Osborne et al. 1988; Osborne 1999; Kriete 2007). At times, they also have been observed preying on marine mammals including pinnipeds and other cetaceans (NMFS 2008; Center for Whale Research 2011). This community has experienced a marked decline in recent years and several populations along the Strait of Juan de Fuca and in Hood Canal may be moving towards extinction (NMFS 2008). It is thought that this decline has been caused by a combination of natural factors including climate cycles as well as human pressures that have led to reductions in prey resources, disturbance from vessel traffic, and increased toxin levels in their environment (Osborne et al. 1988). Southern resident killer whales are known to move through Elliott Bay on occasion but rarely, if ever, approach the nearshore environment of the area of interest.

4.3.7.3 Pacific Eulachon; Southern DPS

The Southern DPS of the Pacific eulachon (*Thaleichthys pacificus*) was listed as threatened under the federal ESA on March 18, 2010 (50 CFR Part 223); critical habitat was designated on October 20, 2011, (50 CFR Part 226) but does not include Puget Sound or its tributaries. A listing status of candidate has been applied by WDFW.

Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish from the eastern Pacific Ocean (NOAA-NMFS 2010d, 2011a). They range from northern California to southwest Alaska and into the southeastern Bering Sea. In the continental United States, most eulachon originate in the Columbia River Basin (NOAA-NMFS 2010d, 2011a). Other areas in the United States where eulachon have been documented include the Sacramento River, Russian River, Humboldt Bay, and several nearby smaller coastal rivers (e.g., Mad River), and the Klamath River in California; the Rogue River and Umpqua Rivers in Oregon; and infrequently in coastal rivers and tributaries to Puget Sound, Washington (NOAA-NMFS 2010d, 2011a). Puget Sound rivers are not known to support established populations of eulachon, although occasional occurrence of eulachon presence has been recorded (see WDFW 2008) (NOAA-NMFS 2010d, 2011a). NMFS has found no record of eulachon spawning stocks occurring in rivers draining into Puget Sound, and information on eulachon spatial distribution from WDFW provides no evidence of eulachon spawning in Puget Sound, now or in the past (NOAA-NMFS 2010d, 2011a).

Eulachon occur in nearshore ocean waters and to 1,000 feet in depth, except for the brief spawning runs into their natal (birth) streams (NOAA-NMFS 2010d, 2011a). Spawning grounds are typically in the lower reaches of larger snowmelt-fed rivers with water temperatures ranging from 39 to 50°F. Spawning occurs over sand or coarse gravel substrates (NOAA-NMFS 2010d, 2011a).They typically spend three to five years in saltwater before returning to freshwater to spawn from late-winter through mid-spring (NOAA-NMFS 2010d, 2011a). Eggs are fertilized in the water column. After fertilization, the eggs sink and adhere to the river bottom, typically in areas of gravel and coarse sand. Most eulachon adults die after spawning. Following hatching, larvae are carried downstream and are dispersed by estuarine and

ocean currents (NOAA-NMFS 2010d, 2011a). Juveniles move from shallow nearshore areas to mid-depth areas. Within the Columbia River Basin, the major and most consistent spawning runs occur in the mainstem of the Columbia River as far upstream as the Bonneville Dam, and in the Cowlitz River (NOAA-NMFS 2010d, 2011a).

Eulachon abundance exhibits considerable year-to-year variability. However, nearly all spawning runs from California to southeastern Alaska have declined in the past 20 years, especially since the mid-1990s (NOAA-NMFS 2010d, 2011a). From 1938 to 1992, the median commercial catch of eulachon in the Columbia River was approximately 2 million pounds but from 1993 to 2006, the median catch had declined to approximately 43,000 pounds, representing a nearly 98 percent reduction in catch from the prior period (NOAA-NMFS 2010d, 2011a). Eulachon returns in the Fraser River and other British Columbia rivers similarly suffered severe declines in the mid-1990s and, despite increased returns during 2001 to 2003, presently remain at very low levels. The populations in the Klamath River, Mad River, Redwood Creek, and Sacramento River are likely extirpated or nearly so (NOAA-NMFS 2010d, 2011a).

Habitat loss and degradation threaten eulachon, particularly in the Columbia River basin. Hydroelectric dams block access to historical eulachon spawning grounds and affect the quality of spawning substrates through flow management, altered delivery of coarse sediments, and siltation (NOAA-NMFS 2010d, 2011a). The release of fine sediments from behind a USACE sediment retention structure on the Toutle River has been negatively correlated with Cowlitz River eulachon returns three to four years later and is thus implicated in harming eulachon in this river system, though the exact cause of the effect is undetermined (NOAA-NMFS 2010d, 2011a). Dredging activities in the Cowlitz and Columbia rivers during spawning runs may entrain and kill fish or otherwise result in decreased spawning success (NOAA-NMFS 2010d, 2011a).

Eulachon have been shown to carry high concentrations of chemical contaminants, and although it has not been demonstrated that high contaminant loads in eulachon result in increased mortality or reduced reproductive success, such effects have been shown in other fish species (NOAA-NMFS 2010d, 2011a). Eulachon harvest has been curtailed significantly in response to population declines. However, existing regulatory mechanisms may be inadequate to recover eulachon stocks (NOAA-NMFS 2010d, 2011a). Climate change may threaten eulachon, particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success (NOAA-NMFS 2010d, 2011a).

4.3.7.4 Bull Trout; Coastal-Puget Sound DPS

The Coastal-Puget Sound DPS of bull trout (*Salvelinus confluentus*) was listed as threatened under the federal ESA on November 1, 1999 (64 FR 58910), and a listing status of candidate has been applied by WDFW. Critical habitat, designated on September 26, 2005 (70 FR 56212), and revised on October 18, 2010 (75 FR 63898), includes the waters found in the study area.

Bull trout exhibit a number of life history strategies. Stream-resident bull trout complete their entire life cycle in the tributary streams where they spawn and rear (USFWS 2005). Most bull trout are migratory, spawning in tributary streams where juvenile fish usually rear one to four years before migrating to either a larger river or lake where they spend their adult life, returning to the tributary stream to spawn

(Fraley and Shepard 1989). Resident and migratory forms may be found together and either can produce resident or migratory offspring (Rieman and McIntyer 1993).

Although bull trout are considered anadromous, those in marine environments often return seasonally to freshwater as subadults, sometimes for several years, before returning to spawn (USFWS 2005). This life history trait is unique to the coastal-Puget Sound population (USFWS 2005). In Puget Sound, adults typically migrate from freshwater to estuarine and marine nearshore environments between late winter and spring to feed on smelt, herring, small salmonids, perch, sand lance, and invertebrates (USFWS 2003). Following this period, they re-enter fresh water from late spring through summer to feed, seek temperature refuge, and to spawn (Goetz et al. 2004). Individuals may alternate this behavior from year to year with it not being fully manifested in younger fish.

Adult bull trout can live up to ten years and become sexually mature after four years (USFWS 2005). Similar to steelhead trout, they spawn multiple times throughout their life. After reaching sexual maturity, they often spawn every year or every other year (USFWS 2003). Spawning occurs in the fall after water temperatures drop below 48°F in unpolluted streams with a clean gravel and cobble substrate and gentle gradient (USFWS 2005). Juveniles eat terrestrial and aquatic insects but shift to preying on other fish as they grow larger (USFWS 2005).

Bull trout are known to utilize Elliott Bay, although they are much less common than other salmonids (Grette and Salo 1986). They are likely to be present in the area of interest as juveniles from March to June and as adults from July to October.

4.3.7.5 Chinook Salmon; Puget Sound ESU

The Puget Sound ESU of Chinook salmon (*Oncorhynchus tshawytscha*) was listed as threatened under the ESA on March 24, 1999 (64 FR 14308), and reaffirmed on June 28, 2005 (70 FR 37160); NOAA-NMFS issued results of a five-year review on August 15, 2011 (76 FR 50448), and concluded that this species should remain listed as threatened. A listing status of candidate has been applied by WDFW. Critical habitat, designated on September 2, 2005 (70 FR 52630), occurs in the study area.

Chinook salmon exhibit considerable variability in size and age of maturation and at least some portion of this variation is genetically determined (NOAA-NMFS 2005). There is a relationship between small size and long distance of migration that may also reflect the earlier timing of river entry and the cessation of feeding for stocks that migrate to the upper reaches of river systems (NOAA-NMFS 2005). Body size, which is related to age, may be an important factor in migration and spawning bed, or redd, construction success (NOAA-NMFS 2005). Juvenile Chinook may spend from three months to two years in freshwater before migrating to estuarine areas as smolts and then into the ocean to feed and mature. Chinook salmon remain in the ocean for one to six years (more commonly two to four years), with the exception of a small proportion of yearling males ("jacks") which mature in freshwater or return only after two or three months in saltwater (NOAA-NMFS 2005).

Like many other salmonids, Chinook salmon have different migratory or run-timing that correspond with season (NOAA-NMFS 2005). These runs include spring, summer, fall, and winter Chinook and indicate when each of these populations migrate from the ocean to freshwater to spawn (NOAA-NMFS 2005). These runs are identified on the basis of when adults enter freshwater to begin migration. Furthermore,

distinct runs also differ in the degree of maturation of the fish at the time of river entry, the temperature and flow characteristics of their spawning site, and their actual time of spawning (NOAA-NMFS 2005). Freshwater entry and spawning timing are believed to be related to local temperature and water flow regimes (NOAA-NMFS 2005).

Two distinct types or races among Chinook salmon have evolved. A "stream-type" Chinook, is found most commonly in headwater streams of large river systems (NOAA-NMFS 2005). They have a longer freshwater residency, and perform extensive offshore migrations in the central North Pacific before returning to their birth or natal streams in the spring or summer months (NOAA-NMFS 2005). Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas (NOAA-NMFS 2005). At the time of saltwater entry, stream-type smolts are larger than their ocean-type counterparts, averaging 73 to 134 mm (3 to 5.25 inches) in length depending on the river system. This increased size allows them to move offshore relatively quickly (NOAA-NMFS 2005).

An "ocean-type" Chinook, is commonly found in coastal streams in North America. Ocean-type Chinook typically migrate to marine environments within the first three months of life, but occasionally spend up to a year in freshwater prior to emigration (NOAA-NMFS 2005). They also spend their ocean life in coastal waters. Ocean-type Chinook salmon return to their natal streams or rivers as spring-, winter-, fall-, summer-, and late-fall runs, however, summer and fall runs predominate (NOAA-NMFS 2005). Ocean-type Chinook salmon tend to use estuaries and coastal areas more extensively than other salmonids for juvenile rearing. Ocean-type Chinook salmon tend to migrate along the coast (NOAA-NMFS 2005).

In the U.S., Chinook salmon are found from the Bering Strait area off Alaska south to Southern California (NOAA-NMFS 2005). Historically, they ranged as far south as the Ventura River, California. Chinook salmon also occur along the coast of Siberia and south to Hokkaido Island, Japan. Salmonid species on the west coast of the United States have experienced dramatic declines in abundance during the past several decades as a result of human-induced and natural factors (NOAA-NMFS 2005).

Chinook salmon are known to utilize the nearshore and offshore environments of Elliott Bay and are present in the study area as juveniles from February to August and as adults from June to November (Grette and Salo 1986; Anchor QEA 2012). However, they may occur in the area year round (Brennan and Higgins 2004; Shannon and Taylor 2005; Fresh 2006). Their affinity for the nearshore is due primarily to the presence of structure and cover from predators (NOAA-NMFS 2005) and its proximity to the terrestrial environment where terrestrial insects are available for prey (Brennan and Higgins 2004; Toft and Cordell 2006). In addition, nearshore environments provide optimal conditions necessary for plankton and other marine invertebrates to thrive, further enhancing the prey base in these areas (NOAA-NMFS 2005).

4.3.7.6 Steelhead; Puget Sound DPS

The Puget Sound DPS of steelhead (*Oncorhynchus mykiss*) was listed as threatened under the federal ESA on May 11, 2007 (72 FR 26722), and a listing status of candidate has been applied by WDFW. Critical

habitat, proposed on January 1, 2011 (76 FR 1392), is currently under review. If critical habitat was designated for this DPS, it would include the study area.

Steelhead populations can be divided into two basic reproductive ecotypes based on the state of sexual maturity at the time of river entry (summer or winter) and duration of spawning migration (Burgner et al. 1992).The population of steelhead in the Green/Duwamish system is dominated primarily by winter-run (native) fish with a small proportion of summer run (hatchery) fish (WDFW 2011b). Winter-run steelhead, also called ocean-maturing steelhead, enter fresh water from December to April at an advanced stage of maturation and spawn from March through June (Hard et al. 2007). While there is some temporal overlap in spawn timing between winter and summer-run steelhead, in basins where both are present, summer-run steelhead spawn farther upstream, often above a partially impassable barrier (NOAA 2011). While winter steelhead spawn shortly after returning to fresh water, adult summer steelhead rely on holding habitat—typically cool, deep pools— for up to 10 months prior to spawning (NOAA 2011).

Unlike many other anadromous salmonids, individual steelhead spawn multiple times throughout their lives, starting in their fourth or fifth year and continuing until reaching a maximum age of approximately 11 years (Puget Sound Partnership 2005; NOAA 2011). Puget Sound steelhead smolts tend to migrate to the ocean to feed and mature after spending two years in fresh water and in estuarine areas near their natal stream (Puget Sound Partnership 2005; NOAA 2011). In these areas, young steelhead trout feed primarily on zooplankton while adults feed on aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows, and other small fishes (including other trout) (Duffy et al. 2005). Following outmigration, Puget Sound steelhead feed in the ocean for one to three years before returning to their natal stream to spawn. They typically spend two years in the ocean before spawning (Puget Sound Partnership 2005; NOAA 2011).

Steelhead are known to occur within the nearshore study area in low densities (Brennan and Higgins 2004; Toft and Cordell 2006), but were not observed along the seawall in 2011 (Anchor QEA 2012). Although most juvenile steelhead reside in freshwater for 1 to 2 years before migrating to marine habitats, multiple age classes have been known to be present in the nearshore environment (Brennan and Higgins 2004; Toft and Cordell 2006). Smoltification and seaward migration occur principally from April to mid-May (NOAA 2011). The migration pattern of steelhead in Puget Sound is not well understood; however, once in the marine environment, it is believed that steelhead smolts move quickly offshore to open water (Hartt and Dell 1986). Adult steelhead occur in Puget Sound for summer and winter runs and may be present in the nearshore during anytime of the year, although their local demographics have not been studied fully (Toft and Cordell 2006). Evidence suggests that steelhead congregate near southern Elliott Bay and migrate up the Duwamish River in mid-December (Brennan and Higgins 2004; Toft and Cordell 2006).

4.3.7.7 Canary Rockfish; Puget Sound DPS

Canary rockfish (*Sebastes pinniger*); Puget Sound DPS were federally listed as a threatened species on April 28, 2010 (75 FR 22276), and a listing status of candidate has been applied by WDFW. No critical habitat has been designated for this species to date.

Canary rockfish share many natural history traits with other rockfish including the federally and state listed bocaccio and yellow rockfish. Canary rockfish are large long-lived rockfish which can live for 75 years and grow up to 2.5 feet in length. They occupy depths between 160 to 820 feet but may be found as deep as 1,400 feet (NMFS 2009; NOAA 2009). Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops where they hover in loose groups just above the bottom (NMFS 2009; NOAA 2009). Juveniles and subadults may be more common than adults in shallower water and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and oil platforms. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore (NMFS 2009; NOAA 2009). Larvae and small juvenile rockfish may remain in open waters for several months being passively dispersed by ocean currents (NMFS 2009; NOAA 2009). They are fished directly and are often caught as bycatch in other fisheries including those for salmon (NMFS 2009; NOAA 2009). Adverse environmental factors including low dissolved oxygen and those causing reproductive impairment, and overfishing led to recruitment failures in the early-to-mid-1990s resulting in the depressed population present today (Methot and Stewart 2005).

Canary rockfish range between Punta Colnett, Baja California, and the Western Gulf of Alaska (Drake et al. 2010). Within this range, canary rockfish are currently most common off the coast of central Oregon (NMFS 2009; NOAA 2009). They were once considered fairly common in the greater Puget Sound area (Holmberg 1967) and associated with the various rocky and coarse habitats that occur throughout the basins of Puget Sound (Miller and Borton 1980). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reported in 2007 that canary rockfish are broadly distributed throughout the Strait of Georgia. Canary rockfish are unlikely to be present in the area of interest due to the lack of supporting habitat features including kelp, piers, rocky bottoms, and outcrops at appropriate depths.

4.3.7.8 Yelloweye Rockfish; Puget Sound DPS

Yelloweye rockfish (*Sebastes ruberrimus*); Puget Sound DPS were federally listed as a threatened species on April 28, 2010 (75 FR 22276), and a listing status of candidate has been applied by WDFW. No critical habitat has been designated for this species to date.

Yelloweye rockfish share many natural history traits with other rockfish including the federally and state listed bocaccio and canary rockfish. Yelloweye rockfish are a very large, long-lived rockfish which can live for 118 years and grow up to 3.5 feet in length. They occupy depths between 80 to 1,560 feet but are most commonly found between 300 to 590 feet (NMFS 2009; NOAA 2009). Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops (NMFS 2009; NOAA 2009). Juveniles and subadults may be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and oil platforms. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore (NMFS 2009; NOAA 2009). Larvae and small juvenile rockfish may remain in open waters for several months being passively dispersed by ocean currents (NMFS 2009; NOAA 2009). They are fished directly and are often caught as bycatch in other fisheries including those for salmon (NMFS 2009; NOAA 2009). Adverse environmental factors including low dissolved oxygen

and those causing reproductive impairment, and overfishing led to recruitment failures in the early- to mid-1990's resulting in the depressed population present today (Methot and Stewart 2005).

Yelloweye rockfish currently range from northern Baja California to the Aleutian Islands, Alaska, but are most common from central California northward to the Gulf of Alaska (Drake et al. 2010). They are less frequently observed in South Puget Sound than North Puget Sound (Miller and Borton 1980), likely due to the larger amount of rocky habitat in North Puget Sound (NMFS 2009; NOAA 2009). Yelloweye rockfish are distributed throughout the Strait of Georgia in northern Georgia Basin including areas around the Canadian Gulf Islands and the numerous inlets along the British Columbia coast (Yamanaka et al. 2006). Their distribution in these areas most frequently coincides with high relief, complex rocky habitats (Yamanaka et al. 2006). Yelloweye rockfish are unlikely to be present in the area of interest due to the lack of supporting habitat features including kelp, piers, rocky bottoms and outcrops at appropriate depths.

4.3.7.9 Marbled Murrelet

Marbled murrelets (*Brachyramphus marmoratus*) were federally listed as a threatened species on September 28, 1992 (57 FR 45328), and a listing status of threatened has been applied by WDFW. Critical habitat was designated on May 24, 1996 (61 FR 26257) but does not occur in the area of interest.

Marbled murrelets are small seabirds of the family Alcidae that occur along the north Pacific coast from the Aleutian Islands and southern Alaska south to central California (USFWS 1992, 1996). The only time they are found on land is during the nesting period from the end of March to the end of September (Hamer and Nelson 1995). Nest sites typically consist of a depression on a moss-covered branch where a single egg is laid. Nest sites are restricted to stands of mature and old-growth forest (Carter 1984; USFWS 1992, 1996, 1997). Because of the scarcity of such stands, it is common for murrelets to fly inland many miles; at least 40 miles in Washington State (see Cooper et al. 2006, 2007). Marbled murrelets only fly to and from their nest sites during crepuscular hours, spending their diurnal hours foraging in marine waters (USFWS 1992, 1996, 1997). During this time, they feed on small fish and invertebrates usually within two miles of shore in open but somewhat sheltered marine waters such as bays or sounds where water depth is less than 330 feet (Carter 1984). Following the breeding season, marbled murrelets disperse away from nearshore coastal waters (USFWS 1992, 1996).

Marbled murrelets are only considered locally common from spring through early summer. Puget Sound; particularly north Puget Sound and the northern part of the outer coast are commonly used during the breeding season. In addition, there also appears to be seasonal movements of marbled murrelets into Puget Sound from British Columbia in the winter (Rodway et al. 1992). It is unclear whether marbled murrelets utilize Elliott Bay, however, the lack of verified sightings (see USGS 2011a) and quality foraging habitat suggest their presence would be rare.

4.3.7.10 Steller Sea Lion; Eastern DPS

The eastern DPS of the Steller sea lion (*Eumetopias jubatus*) was federally listed as threatened under the ESA on November 26, 1990 (55 FR 49204), (the endangered western population only occurs in western Alaska) and a listing status of threatened has been applied by WDFW. A proposed rule to remove the

eastern DPS from ESA listing was submitted on April 18, 2012 (77 FR 23209). Critical habitat was designated on August 27, 1993 (50 CFR 226.202), but does not occur in the study area.

Steller sea lions are distributed mainly around the coasts to the outer continental shelf along the North Pacific Ocean rim from northern Hokkaiddo, Japan through the Kuril Islands and Okhotsk Sea, Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California (NMFS 1992). The population is divided into the Western and the Eastern DPSs at 144 degrees west longitude (Cape Suckling, Alaska) (NMFS 1992). The Eastern DPS includes sea lions living in southeast Alaska, British Columbia, California, and Oregon and Washington (NMFS 1992). Population surveys suggest that the Eastern U.S. DPS is stable or increasing in the northern part of its range (Southeast Alaskan and British Columbia), while the remainder of the Eastern DPS and all the Western DPS is declining (NMFS 1992). The primary cause of this decline is from anthropogenic threats including boat strikes, contaminants/pollutants, habitat degradation, illegal hunting/shooting, offshore oil and gas exploration, direct and indirect interactions with fisheries, and subsistence harvests by natives in Alaska and Canada (NMFS 1992).

Steller sea lions are opportunistic predators, feeding primarily on a wide variety of fishes and cephalopods. Pacific hake, Pacific herring (*Clupea harengus*), Pacific sand lance (*Ammodytes hexapterus*), Pacific cod (*Gadus macrocephalus*), and various salmon species compose the bulk of their diet (Gearin et al. 1999). Steller sea lions have also been known to prey on harbor seal, fur seal, ringed seal, and possibly sea otter pups, but this would represent only a supplemental component to the diet (NMFS 1992). Steller sea lions are usually seen at haul out sites such as rocks or buoys, which are thought to provide protection from predators, severe climate or sea surface conditions, and are close to prey resources (NMFS 1992). They occur year-round in Washington waters but their numbers decrease during the summer months when many migrate to Oregon and British Columbia rookeries to breed (NMFS 1992).

Locally, Steller sea lions are at most an infrequent visitor. Breeding rookeries and major haul-out sites have not been documented in Puget Sound (NMFS 1992) although small haul-outs have been identified in the surrounding area (Jefferies 2000). It is unclear to what extent Steller sea lions utilize Elliott Bay; however, the lack of verified sightings and low quality foraging or haul-out habitat suggest their presence is rare.

4.3.7.11 Coho Salmon; Puget Sound/Georgia Basin ESU

The Puget Sound/Georgia Basin ESU of coho salmon (*Oncorhynchus kisutch*) was listed as a species of concern under the federal ESA on April 15, 2004 (69 FR 19975), and a listing status of candidate has been applied by WDFW. No critical habitat has been designated for this ESU.

Coho salmon spend approximately the first half of their life cycle rearing and feeding in streams and small freshwater tributaries. Spawning habitat is small streams with stable gravel substrates. The remainder of their life cycle is spent foraging in estuarine and marine waters of the Pacific Ocean. Juvenile coho do not appear to be as estuary dependent as Chinook or chum salmon, but have been found to reside in estuaries for a few days to a few weeks (Aitkin 1998).

Coho were historically distributed throughout the North Pacific Ocean from central California to Point Hope, Alaska, through the Aleutian Islands, and from the Anadyr River, Russia, south to Hokkaido, Japan. Coho probably inhabited most coastal streams in Washington, Oregon, and central and northern California. Some populations, now considered extinct, are believed to have migrated hundreds of miles inland to spawn in tributaries of the upper Columbia River in Washington, and the Snake River in Idaho. The long-term trend for the listed ESUs has been downward, although some returns with good numbers have occurred during the last decade.

Coho salmon are known to utilize Elliott Bay and are present in the study area as juveniles from March to August and as adults from August to November (Grette and Salo 1986; Anchor QEA 2012). It is assumed that they move from the Green/Duwamish River north through the study area, although potentially further offshore than the proposed project work zone (Kerwin and Nelson 2000).

4.3.7.12 Chum Salmon; Puget Sound/Strait of Georgia ESU

The listing of the Puget Sound/Strait of Georgia ESU of chum salmon (*Oncorhynchus keta*) was determined to not be warranted under the ESA on March 10, 1998 (50 CFR Parts 226 and 227), but a listing status of candidate has been applied to this species by WDFW. No critical habitat has been designated for this ESU.

Chum salmon spawn in the lowermost reaches of rivers and streams, typically within 62 miles of the ocean (NOAA 1998). Spawning sites are often near springs. They migrate almost immediately after hatching to estuarine and ocean waters, in contrast to other Pacific salmonids, which migrate to sea after months or even years in freshwater (NOAA 1998). This means that survival and growth in juvenile chum salmon depend more on favorable estuarine and marine conditions than freshwater conditions (NOAA 1998).

Chum salmon have the widest natural geographic and spawning distribution of any Pacific salmonid, primarily because its range extends farther along the shores of the Arctic Ocean than that of the other salmonids (NOAA 1998). Spawning populations are known from Korea and Japan and into the far north of Russia. Historically, in North America, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey, California (NOAA 1998). Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast (NOAA 1998).

Chum salmon may historically have been the most abundant of all Pacific salmonids but have suffered severe declines in two ESUs; the Hood Canal ESU and the Columbia River ESU. However, the other two ESUs identified for this species; the Puget Sound/Strait of Georgia ESU and Pacific Coast ESU, have maintained relatively robust populations (NOAA 1998). All populations have experienced declines in abundance during the past several decades as a result of human-induced and natural factors (NOAA 1998). Chum salmon are known to utilize Elliott Bay and are present in the study area as juveniles from February to July and as adults from July to September (Grette and Salo 1986; Anchor QEA 2012).

4.3.8 Essential Fish Habitat

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act and the 1996 Sustainable Fisheries Act (SFA), an EFH evaluation of impacts is necessary for the proposed action. EFH is defined by the Magnuson-Stevens Fishery Conservation and Management Act in 50 CFR 600.905-930 as "…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Terminology definitions associated to this language is as follows:

- Waters: include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate.
- Substrate: includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- Necessary: the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.
- Spawning, breeding, feeding, or growth to maturity: covers a species' full life cycle.

EFH guidelines published in federal regulations (50 CFR 600.815(a)(8)) identify habitat areas of particular concern (HAPC) as types or areas of habitat within EFH that are identified based on one or more of the following considerations (PFMC 2005):

- The importance of the ecological function provided by the habitat;
- The extent to which the habitat is sensitive to human-induced environmental degradation;
- Whether, and to what extent, development activities are or will be stressing the habitat type; and
- The rarity of the habitat type.

Based on these considerations, the Pacific Fishery Management Council, in conjunction with NOAA, has designated both areas and habitat types as HAPC. In some cases, HAPC identified by means of specific habitat type may overlap with the designation of a specific area (PFMC 2005). The HAPC designation covers the net area identified by habitat type or area. Designating HAPC facilitates the consultation process by identifying ecologically important, sensitive, stressed or rare habitats that should be given particular attention when considering potential non-fishing impacts (PFMC 2005). Their identification is the principal way in which the Council can address these impacts (PFMC 2005).

Both EFH and HAPC have been identified in the proposed action area, including two types of EFH: Pacific Coast Groundfish EFH and West Coast Salmon EFH, and four HAPC: estuaries, canopy kelp, seagrass, and rocky reefs (PFMC 1999, 2005; NOAA 2011; NOAA-NMFS 2011b). Each of these EFHs and HAPCs are discussed below.

4.3.8.1 Essential Fish Habitat in the Study Area

4.3.8.1.1 Pacific Coast Groundfish EFH

The overall extent of groundfish EFH for all Fishery Management Units (FMU) species has been identified as all waters and substrate within the following areas:

- Depths less than or equal to 11,482 feet to mean higher high water level (MHHW) or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per trillion (ppt) during the period of average annual low flow;
- Seamounts in depths greater than 11,483 feet as mapped in the EFH assessment GIS; and
- Areas designated as HAPC not already identified by the above criteria.

Ninety groundfish species have been identified under this EFH (NOAA 2011) with 81 potentially occurring in the proposed action area (NOAA-NMFS 2011b). Full discussions of the species listed under the Pacific Coast Groundfish EFH that receive protection under the federal ESA or state of Washington conservation programs are in Section 4.3.7, Threatened, Endangered, and Candidate Species. Other discussion of EFH habitat features found in the proposed action area are provided in Section 4.3.8, Essential Fish Habitat. A complete list of species under the Pacific Coast Groundfish EFH is presented in Appendix A.

4.3.8.1.2 West Coast Salmon EFH

EFH for the West Coast salmon fishery refers to those waters and substrate necessary for salmon production needed to support a long-term, sustainable salmon fishery and salmon contributions to a healthy ecosystem. To achieve that level of production, EFH must include all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California (PFMC 1999). In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (230.2 miles) offshore of Washington, Oregon, and California north of Point Conception (PFMC 1999). Foreign waters off Canada, while still salmon habitat, are not included in salmon EFH because they are outside United States jurisdiction. The West Coast salmon fishery EFH also includes the marine areas off Alaska designated as salmon fishery EFH by the North Pacific Fishery Management Council (NPFMC). This identification of EFH is based on the descriptions of habitat utilized by coho, Chinook and pink salmon (PFMC 1999). Although freshwater EFH has also been established for these species, it does not apply to this proposed project.

Seventy-six west coast salmon stocks have been identified under the West Coast Salmon EFH (NOAA 2011); nine of which have the potential to occur in the proposed action area. Specific discussions of those species that also receive protection under the federal ESA or state of Washington conservation programs are in Section 4.3.7, Threatened, Endangered, and Candidate Species. A complete list of species under the West Coast Salmon EFH is presented in Appendix A.

4.3.8.2 Habitat Areas of Particular Concern in the Study Area

4.3.8.2.1 Estuaries

Estuaries are protected nearshore areas such as bays, sounds, inlets, and river mouths that are influenced by ocean and freshwater (PFMC 2005). Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish and marine habitats within close proximity (Haertel and Osterberg 1967). Estuaries tend to be shallow, protected, nutrient rich, and are biologically productive, providing important habitat for marine organisms, including groundfish and salmon.

The inland extent of the estuary HAPC is defined as MHHW or the upriver extent of saltwater intrusion defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow (PFMC 2005). The seaward extent is an imaginary line closing the mouth of a river, bay, or sound; and to the seaward limit of wetland emergents, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds (PFMC 2005). This HAPC also includes those estuary-influenced offshore areas of continuously diluted seawater (PFMC 2005). This definition is based on Cowardin et al. (1979).

4.3.8.2.2 Canopy Kelp

Of the habitats associated with the rocky substrate on the continental shelf, kelp forests are of primary importance to the ecosystem and serve as important fish habitat. Kelp forest communities are found relatively close to shore along the open coast. These subtidal communities provide vertically-structured habitat throughout the water column: a canopy of tangled blades from the surface to a depth of 10 feet; a mid-water, stipe region; and the holdfast region at the seafloor (PFMC 2005). Kelp stands provide nurseries, feeding grounds, and shelter to a variety of fish species and their prey (Ebeling et al. 1980; Feder et al. 1974). Giant kelp communities are highly productive relative to other habitats, including wetlands, shallow and deep sand bottoms, and rock-bottom artificial reefs (Bond et al. 1998). Their net primary production is an important component to the energy flow within nearshore food webs (PFMC 2005). Foster and Schiel (1985) reported that the net primary productivity of kelp beds may be the highest of any marine community. The net primary production of seaweeds in a kelp forest is available to consumers as living tissue on attached plants, as drift in the form of whole plants or detached pieces (e.g., detritus), and as dissolved organic matter exuded by attached and drifting plants (Foster and Schiel 1985).

The canopy kelp HAPC includes those waters, substrate, and other biogenic habitat associated with canopy-forming kelp species such as *Macrocystis* spp. and *Nereocystis* sp. (PFMC 2005)

4.3.8.2.3 Seagrass

Seagrass species found on the West Coast of the U.S. include eelgrass species (*Zostera* spp.), widgeongrass (*Ruppia maritima*), and surfgrass (*Phyllospadix* spp.) (PFMC 2005). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries and occasionally in other nearshore areas, such as the Channel Islands and Santa Barbara

littoral (PFMC 2005). Surfgrass is found on hard-bottom substrates along higher energy coasts. Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993; Hoss and Thayer 1993).

The seagrass HAPC includes those waters, substrate, and other biogenic features associated with eelgrass species, widgeongrass, or surfgrass (PFMC 2005).

4.3.8.2.4 Rocky Reefs

Rocky habitats are generally categorized as either nearshore or offshore in reference to the proximity of the habitat to the coastline. Rocky habitat may be composed of bedrock, boulders, or smaller rocks, such as cobble and gravel. Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for groundfish (PFMC 2005).

The rocky reefs HAPC includes those waters, substrates and other biogenic features associated with hard substrate (bedrock, boulders, cobble, gravel, etc.) to MHHW (PFMC 2005).

CHAPTER 5. CONSTRUCTION EFFECTS AND MITIGATION

This chapter describes the anticipated effects on fish, wildlife, and vegetation associated with the typical elements of construction included in the EBSP build alternatives and No Action Alternative. Also included are discussions of the BMPs and mitigation measures that would be part of the project design and management practices to reduce impacts associated with the typical elements of construction used in the EBSP build alternatives. In most cases, only general aspects of each alternative are addressed and discussed at length; however, in cases where specific aspects have the potential to impact biological resources, important details are also described and assessed.

5.1 NO ACTION ALTERNATIVE

Under the No Action Alternative, the EBSP would not be constructed; thus there are no anticipated effects. The No Action Alternative would provide no environmental benefits through habitat enhancements to the biological resources in the study area and nearshore and upland habitat would remain highly urbanized, degraded, and compromised. However, the No Action Alternative would not cause direct detrimental effects from construction activities to the environment. Operational effects associated with the No Action Alternative are described in Chapter 6.

In the event that any No Action scenario occurs, several detrimental effects are anticipated to be incurred by the biological resources in the study area:

Minimal Damage: It would be assumed that under the Minimal Damage scenario, direct impacts from the damage would have a minimal impact on the nearshore and upland areas and any required repairs would be performed with regard to minimizing effects on biological resources to the extent possible.

Loss of Functionality: The damage sustained under the Loss of Functionality scenario would likely cause the release of pollutants from upland and marine sources into the nearshore and shifting debris would harm or kill organisms in the area. Repairs on the seawall would be substantial but would be assumed to minimize effects on biological resources to the extent possible. However, organisms not able to flee from the area during construction such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) would likely be killed by the action.

Collapse of the Seawall: As with the Loss of Functionality scenario, the Collapse of the Seawall scenario would have similar impacts but would be much greater in scope; the Collapse of the Seawall scenario could result in substantial quantities of debris throughout the study area as all materials in the vicinity of the collapse could be expected to enter the aquatic nearshore. Repairs of the seawall would be assumed to be substantial, increasing the potential for detrimental effects on the environment such as through the release of pollutants, detrimental impacts on listed species, or degradation of habitat features through the anticipated extensive construction activities. The most likely effects would be burial of existing organisms and habitats along the seawall by soils, concrete, wood and other debris. The City and other agencies would likely immediately place large rock or other features to stabilize the shoreline, further burying existing habitats. Over the longer-term, additional repairs and rebuilding would occur but would not likely remove the bulk of the material that had sluiced out into Elliott Bay.

5.2 UNDERWATER CONSTRUCTION NOISE

Underwater noise impacts from pile installation and removal activities were assessed using data and procedures from the WSDOT Biological Assessment Guidance (NOAA-NMFS 2012d; WSDOT 2009, 2011) (see the Noise and Vibration Discipline Report [SDOT 2012d] for additional details). Analysis procedures include calculations developed by NOAA-NMFS and the USFWS to estimate critical distances at which marine mammals, fishes, and birds are likely to be affected by in-water pile installation or removal activities. The approach provides an empirical database to assist in predicting underwater sound levels from marine pile driving projects and determining the effectiveness of measures used to control the noise.

Unlike sound levels in air, which are typically used to assess impacts to humans and thus are weighted to correspond to the same frequency range that humans hear, sound levels underwater are not weighted and thus account for the entire frequency range of interest. Sound pressure levels outlined in the WSDOT model are underwater and have a reference pressure of 1 microPascal; to calculate an equivalent airborne noise, 26 dB should be subtracted.

Table 5-1 outlines measured noise levels for the types of pilings proposed for the EBSP, concrete pilings and steel sheet piles. Table 5-2 outlines NOAA-NMFS and USFWS threshold noise levels for potential injury and behavioral effects to fish and wildlife species. According to NOAA-NMFS interim guidance on in-water pile-driving actions, the noise disturbance threshold for fish is 150 dB_{RMS} and the injury threshold is 187 dB_{SEL} for fish greater than or equal to 2 grams and 183 dB_{SEL} for fish less than 2 grams (and 206 dB_{PEAK} for fish of all size). For marbled murrelets, the in-water auditory injury threshold is 202 dB_{SEL}, the non-auditory injury threshold is 208 dB_{SEL}, non-injurious hearing threshold is 183 dB_{SEL} and the potential behavioral effect zone is 150 dB_{RMS}.

TABLE 5-1. UNATTENUATED NOISE LEVELS FOR DIFFERENT TYPES OF PILINGS PROPOSED FOR THE ELLIOTT BAY SEAWALL PROJECT

Measured Levels for Pile-Related Activities			
Pile Type	**Peak Level**	**Sound Exposure Level (SEL)**	**Root Mean Squared (RMS) Level**
24-inch Octagonal Concrete Pile (impact)	188	166	176
24-inch AZ Steel Sheetpile (vibratory)	182	165	165
24-inch AZ Steel Sheetpile (impact)	205	180	190

Source: Caltrans 2009
Notes: dB – decibels, RMS – root mean squared

TABLE 5-2. CURRENT NOISE THRESHOLDS FOR FISH AND WILDLIFE TAXA

Criterion Definition	In-water Sound Threshold Pinnipeds	In-water Sound Threshold Cetaceans	In-water Sound Threshold Fish	In-water Sound Threshold Marbled Murrelet
Injury	190 dB_{RMS}	180 dB_{RMS}	187 dB_{SEL} for fish >2 g 183 dB_{SEL} for fish <2 g 206 dB_{PEAK}	202 dB_{SEL} auditory 208 dB_{SEL} non-auditory 183dB_{SEL} non-injurious auditory
Behavioral disruption for impulsive noise (impact pile installation)	160 dB_{RMS}	160 dB_{RMS}	150 dB_{RMS}	150 dB_{RMS}
Behavioral disruption for continuous noise (vibratory pile installation/removal)	120 dB_{RMS}	120 dB_{RMS}	150 dB_{RMS}	150 dB_{RMS}

Prior to the implementation of the interim guidance, NOAA-NMFS had been using a 160 dB_{RMS} threshold for marine mammal behavioral disruption regardless of sound type (continuous or impulsive). Under the current interim guidance, marine mammal exposure to sound from continuous sources (such as from vibratory pile installation) above an intensity of 120 dB_{RMS} is assumed to cause behavioral disruption. For impulsive sources (such as from impact pile installation), marine mammal exposure to sound above an intensity of 160 dB_{RMS} continues to be the threshold for behavioral disruption.

The sound thresholds for injury to marine mammals; 190 dB_{RMS} for pinnipeds and 180 dB_{RMS} for cetaceans, are also unchanged under the current interim guidance. There is no potential for injury of marine mammals from exposure to sound levels below 180 dB_{RMS}.

Pile manipulation sound threshold levels of harassment permitted under the MMPA are based on NOAA-NMFS current interim guidelines and previously existing guidelines are summarized in Table 5-2.

Ambient conditions in the vicinity of the EBSP have been measured to be 126 dB_{RMS} (Laughlin 2011). Thus, it is assumed the entire action area has high ambient noise levels due to ferry vessel and other boat traffic. In-water noise above ambient conditions will result from vibratory pile installation and and/or removal of sheet piles, timber piles, and concrete piles, and impact driving of concrete piles and proofing of weight-bearing sheet piles.

Vibratory equipment will be used to install and remove an estimated 1,738 sheet pile pairs for each proposed alternative. Installation is expected to take 50 days per construction segment in Phase 1 and 35 days in Phase 2. A limited number of sheet piles will be impact proofed (e.g., if they are load bearing or encounter consolidated sediments). Based on current estimates, in Phase 1, 190 sheet pile pairs will be proofed using an impact hammer and 130 pairs in Phase 2. This action will result in 63 sheet-pile pairs/segment in Phase 1 and 65 sheet-pile pairs/segment in Phase 2. Assuming an eight-hour work day and that eight sheet piles will be proofed per day at 100 strikes per sheet pile, nearly 800 strikes are proposed to occur per day. For permanent concrete piles, an estimated 175 piles will be installed during Phase 1 (including the Washington Street Boat Landing) and 100 during Phase 2. Assuming eight piles

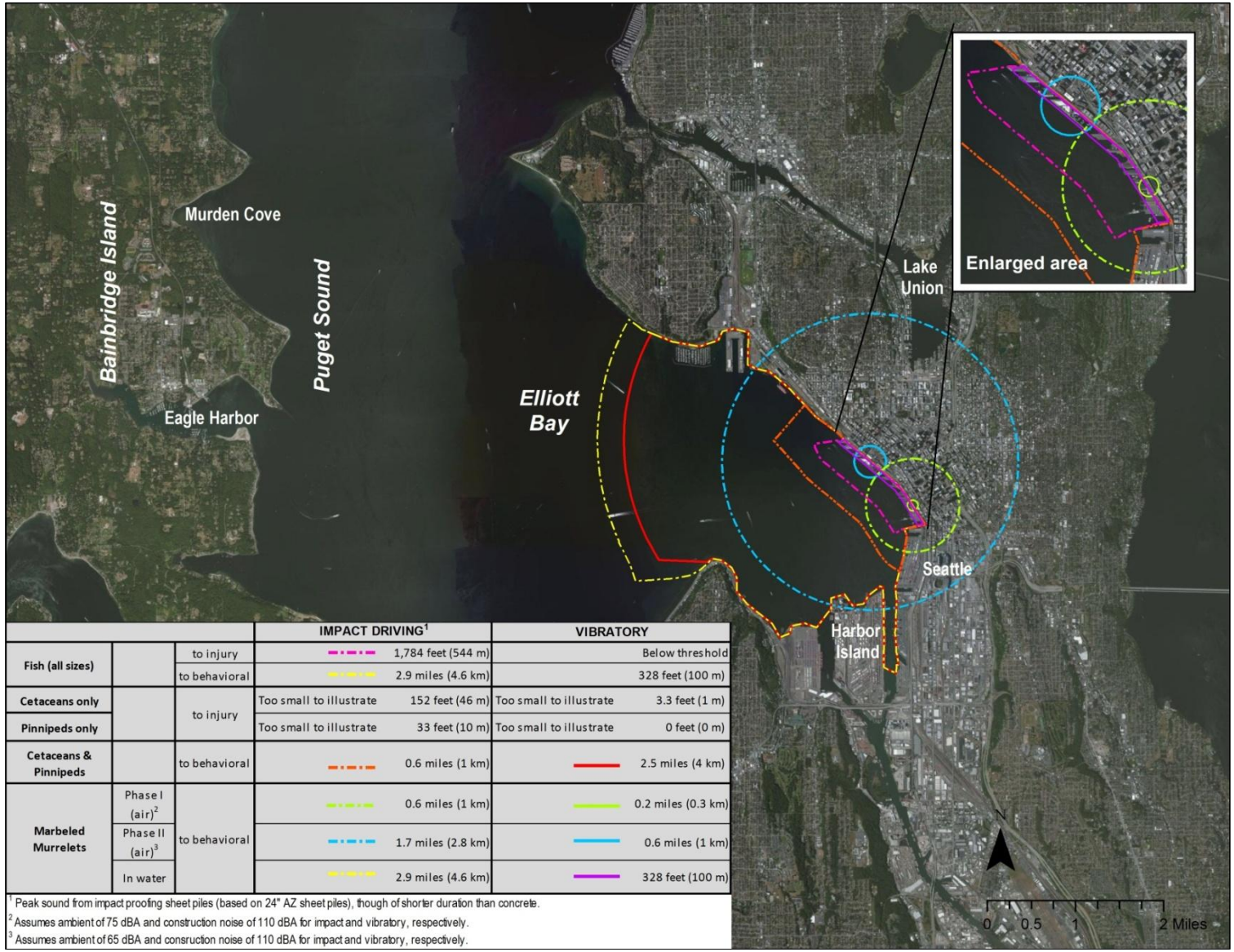
can be installed per day at an estimated 1,500 strikes per pile, an estimated 12,000 strikes are estimated to occur per 10-hour work day.

Using the NMFS calculator (NOAA-NMFS 2012d) and previously described assumptions on noise produced from sheet-pile proofing, the extent to which in-water pile-driving activities could impact listed species was estimated. Using published data on similarly sized structures, it was assumed that sound pressures resulting from the installation and removal of sheet piles using vibratory equipment is expected to be approximately 182 dB_{PEAK} or 165 dB_{RMS} (assumed 24-inch steel A-Z sheet pile; Caltrans 2009). Sound pressures resulting from impact hammer proofing, which is expected to result in the greatest sound impacts, but will be of shorter and limited duration, is approximately 205 dB_{PEAK} or 190 dB_{RMS} (Caltrans 2009). Likewise, impact driving of concrete piles would produce sound levels of 188 dB_{PEAK}, or 176 dB_{RMS} (Caltrans 2009).

For the purpose of this Discipline Report, all new piling installations were evaluated as if it they would occur in water without attenuation. Impact pile driving of the permanent concrete pilings would occur behind the temporary containment wall and may be somewhat attenuated; however, flanking around the wall is also likely. Impact pile driving behind a dewatered coffer dam has been shown to reduce noise from installing a concrete pile by 20 to 30 dB below unattenuated conditions (average of 25 dB) and a non-dewatered coffer dam by 0 to 10 dB (average of 5 dB) (Reyff et al. 2002, 2003; summarized in Caltrans 2007, 2009).

Based on previously described assumptions, unattenuated sound levels for impact driving are around the thresholds for injury to fish, marine mammals, and marbled murrelets at specific distances from the point source of noise (Figure 5-1). More specifically, for impact pile driving of sheet piles, the threshold for potential injury for fish is 1,784 feet (544 meters), marine mammals is 152 feet (46 meters), and marbled murrelets is 95 feet (29 meters). For impact pile driving of concrete piles, the threshold for potential injury to fish is 383 feet (117 meters), marine mammals is 18 feet (5 meters), and marbled murrelets is 69 feet (21 meters). Vibratory pile installation or removal has only been examined for sheet piles. However, studies and results from the noise calculator (NOAA-NMFS 2012d) show injury would not occur to fish, marine mammals, or to marbled murrelets from vibratory pile-related activities because levels would never reach injury thresholds.

Behavior changes from unattenuated pile-related noise would typically occur at greater distances from the point source than for noise-related injury because the thresholds are lower. More specifically, for impact pile driving of sheet piles, the threshold for potential behavioral effects to fish and marbled murrelets is 2.88 miles (4,642 meters) and marine mammals is 0.6 miles (1,000 meters. For impact pile driving of concrete piles, the threshold for potential behavioral effects to fish and marbled murrelets is 0.3 mile (541 meters) and marine mammals is 383 feet (117 meters). Noise from vibratory pile installation or removal has only been examined for sheet piles. Using data from studies and the noise calculator, the threshold for potential behavioral disturbance to fish and marbled murrelets was calculated to be 328 feet (100 meters) and marine mammals is 2.5 miles (3,981 meters).



			IMPACT DRIVING[1]		VIBRATORY	
Fish (all sizes)		to injury		1,784 feet (544 m)		Below threshold
		to behavioral		2.9 miles (4.6 km)		328 feet (100 m)
Cetaceans only		to injury	Too small to illustrate	152 feet (46 m)	Too small to illustrate	3.3 feet (1 m)
Pinnipeds only			Too small to illustrate	33 feet (10 m)	Too small to illustrate	0 feet (0 m)
Cetaceans & Pinnipeds		to behavioral		0.6 miles (1 km)		2.5 miles (4 km)
Marbeled Murrelets	Phase I (air)[2]	to behavioral		0.6 miles (1 km)		0.2 miles (0.3 km)
	Phase II (air)[3]			1.7 miles (2.8 km)		0.6 miles (1 km)
	In water			2.9 miles (4.6 km)		328 feet (100 m)

[1] Peak sound from impact proofing sheet piles (based on 24" AZ sheet piles), though of shorter duration than concrete.
[2] Assumes ambient of 75 dBA and construction noise of 110 dBA for impact and vibratory, respectively.
[3] Assumes ambient of 65 dBA and consruction noise of 110 dBA for impact and vibratory, respectively.

Figure 5-1. Maximum Distances at which Species would be Affected by Impact and Vibratory Pile Driving

Based on these calculations and assuming noise will define the largest potential impact zone of all construction effects, the action area would extend up to approximately 2.88 miles into the marine environment (i.e., the largest calculated threshold). In general, properties of in-water noise allow it to propagate at ever diminishing levels until it strikes dry land or other structures (which surround the construction site on three sides within 2.5 miles). As a result, it is expected that pile-related construction noise would extend throughout the nearshore and open water environments and a limited distance into the East Waterway (a highly industrialized channel within the Duwamish River).

Examples of behavioral changes in response to noise include rapid turning or movement away from the noise. Fish hear by converting noise pressure waves to vibrations. A fish's swim bladder acts as the transducer to convert the noise pressure to vibrations; thus rapid changes in volume can result in tearing, reduced hearing sensitivity, and loss of hydrostatic control. Both juvenile and adult salmon could respond to disturbance by delaying foraging and avoiding the project footprint. Listed juvenile salmon (primarily Chinook) have been recently observed along the seawall from April through September but steelhead and bull trout were not observed (Anchor QEA 2012). It can be assumed that adult salmonids may be in Elliott Bay at any time during the year but would likely occupy deeper water away from the project footprint. The requested in-water work window extension and pile driving may affect a small number of Chinook salmon, bull trout, or steelhead juveniles in either March or September. In September, juvenile fish will generally be larger (late migrants) and more likely to use deeper water, more offshore habitats (Fresh 2006). Similarly, as steelhead and bull trout rear longer in freshwater they would be larger at migration into the estuary and use deeper waters. The majority of the temporary containment wall will be installed using vibratory equipment with limited use of impact hammering to proof. Noise and disturbance resulting from construction activities, particularly from pile driving, could potentially result in behavioral effects on marine mammals, birds, and fish, and potentially cause injury to fish weighing less than 2 g up to 1,784 feet from the pile driving activity. Applicable approvals and permits will be obtained and mitigation measures intended to reduce impacts on these taxa will be employed as feasible (i.e., noise attenuation measures).

5.3 ALTERNATIVE A

Alternative A proposes a soil improvement seawall structural option, but a BSP structural option could be used and still maintain the wall location (see Section 1.6.3), habitat improvements and other proposed features. However, in the case where Alternative A construction methods incorporate other structural options, effects related to the substituted options would apply. Under Alternative A, all locations along the seawall except for one, would be constructed behind the existing structure which would be removed as needed; the exceptions would be in Zone 1, where the wall is installed exactly in the place of the existing wall, and in Zone 3, which would have the new seawall placed three feet in front of the existing structure. This general plan would result in the majority of seawall-related construction to likely be isolated from Elliott Bay via a temporary containment wall and would be considered upland work, substantially reducing the potential for negative effects on the nearshore. In-water work, however, would still be required to complete this alternative, particularly the installation of in-water habitat features.

In most cases in Alternative A, the construction sequence requires three in-water work actions that are slated to occur in the nearshore. The first in the sequence is the removal or displacement of some of the riprap currently placed at the toe of the existing seawall; the second is the placement and removal of a temporary containment wall as a BMP to contain water quality contaminants; and the third is the installation of in-water habitat features. Other construction improvements are slated to occur under Alternative A and will also be discussed.

5.3.1 Installation and Removal of Temporary Containment Wall

The installation and removal of the temporary containment wall requires three major actions: the removal or displacement of riprap, placement of a sheet-pile wall in the nearshore for one or two construction seasons, and the removal of the sheet-pile wall. Various disturbances to the nearshore marine environment and upland environment would likely result from these actions as described in this section, causing impacts to the biological resources in the area.

The removal or displacement of riprap is necessary to access the substrate for installation of additional construction elements including the temporary containment wall and, and in Zone 3, the construction of the new seawall. Originally, the riprap was installed for protection and stabilization of the seawall toe. Over time, movement of the riprap has occurred due to processes such as sinking and wave and tidal action, requiring subsequent placement of additional riprap to maintain the required protection. Sediments adjacent to the riprap are known to contain low to moderate levels of various pollutants such as PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [SDOT 2012a] for details). Together, these past actions have resulted in a large amount of riprap to be present along the majority of the length of the existing seawall. Because the removal of riprap would take place waterward of the existing seawall, it would be considered in-water work. Effects from this action, therefore, are anticipated to be detrimental to the nearshore environment. The removal of riprap would likely disturb and at least partially re-suspend sediments and pollutants in the water column where they could be redistributed in the nearshore through tidal and wave action. Recent video from nearshore surveys (SDOT 2011; Anchor QEA 2012); however, have suggested sediment resuspension from disturbance to be minimal to moderate (sand/silt/shell hash mixed sediments re-suspend, but settle quickly). Regardless, any resuspension of pollutants may increase the potential for transfer of contaminants to the water column or to marine organisms including some listed species such as salmonids. The disturbance caused by the proposed action (i.e., noise, vibration, movement, etc.) would likely, at a minimum, alter the behavior of all fish and wildlife, including marine mammals, near the action area, likely causing them to flee, if able. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow moving species (e.g., starfish and crabs), could be hurt or killed directly by the action, or from exposure due to remaining attached to the excavated riprap. Upland wildlife species would also likely be disturbed and leave the area. Because this action is slated to occur throughout the nearshore of the project area, the negative impact would occur along the entire length of the wall. However, the use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15) and using silt curtains to contain re-suspended

sediments would reduce the negative impact. It should also be noted that this action would only have a short-term effect and once complete, the riprap would be moved off site or reused in the habitat features. With use of BMPs, the impact from the removal or displacement of riprap in the nearshore environment is therefore, anticipated to be short term and moderate.

Following riprap removal or displacement, a temporary containment wall constructed of sheet pile, will be installed in each construction segment waterward of the existing seawall and would remain for 1 construction season, after which, it would be removed. The purpose of the temporary containment wall is to isolate construction work areas from the nearshore and prevent materials, equipment, activities, and wastes from degrading Elliott Bay. Following installation, the area landward of the temporary containment wall would be considered "isolated" and work could occur outside of the designated in-water work window. The construction sequence is slated to have the temporary containment wall installed in each construction segment at different times; however, over the duration of the project, the entire length of the seawall (approximately 6,328 feet) would have the temporary containment wall installed and removed. It is estimated that 1,738 sheet piling segments would need to be installed and removed in this effort. Although the temporary containment wall would function as a barrier intended to isolate the area of construction from the nearshore environment, the location of its installation on the waterward side of the existing seawall would be considered in-water work.

As with the removal of riprap, the installation of the temporary containment wall would likely disturb sediments and associated contaminants, potentially causing their resuspension in the nearshore. In addition, machinery and techniques that would likely be used to install sheet pile such as vibratory and impact hammers, are known to disturb or in extreme instances, injure or kill organisms such as fish found in close proximity (see Feist et al. 1992; Turnpenny et al. 1994; summarized in Popper and Hastings 2009). Upland species would also likely be disturbed by this action and associated noise (see Laughlin 2006). The use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15), working during low tides, restricting use of impact hammers to only when necessary, and deploying silt curtains to contain re-suspended sediments, would reduce the negative effects. It should also be noted that this action would only have temporary effects during the installation and removal of the temporary containment wall, but would not substantially impact the nearshore once the sheet piles are in place or removed. With use of BMPs, the impact from the installation and removal of the temporary containment wall in the nearshore environment is therefore, anticipated to be short term and moderate.

5.3.2 Seawall Pullback and Construction

The majority of construction is slated to occur behind the temporary containment wall in areas that are currently upland and occupied by the existing seawall and infill supporting the sidewalk and Alaskan Way. The purpose of the temporary containment wall is to confine construction activities to areas landward of the nearshore and prevent the movement of water and sediment quality contaminants into Elliott Bay. In addition, the existing seawall would remain in place through most of construction in all zones but Zones 1 and 3, to further enhance this barrier. Since the majority of the proposed construction is slated to be in areas that are currently upland and would be physically separated from

the nearshore by the temporary containment wall, and in most cases, the existing seawall, it would likely be considered upland work regardless of its close proximity to the nearshore.

Excavation required for the wall pullback would occur landward of the temporary containment wall and only in urban upland areas. This would minimize direct adverse effects to natural-type habitat, as virtually none currently exists landward of the nearshore in the proposed project area. Disturbance is expected to occur to upland wildlife that currently reside in the area, however, none are protected species and all are mobile and are expected to move from the area unharmed. The net increase in aquatic and riparian habitat would provide a long-term benefit that would largely reduce potential adverse effects for any loss of existing habitat or temporary disturbance to existing wildlife. Alternative A is slated to require substantially less excavation than Alternative B and a minor reduction in excavation compared to Alternative C, and would likely have less adverse effects and less overall disturbance to wildlife. Excavation would have a short-term and minor effect on the biological resources in the study area. Although excavation would expose existing CSO and stormwater outfalls and their associated infrastructure, they would be managed to retain their function during and after the proposed construction and would generally be left in their current locations where they exit the existing seawall structure.

Following the initiation of excavation behind the temporary containment wall, it is assumed that water would move into the work area from various sources including rain, groundwater, tidal fluctuations, and construction sources, and mix with and mobilize contaminated sediments. The temporary containment wall is intended to restrict this construction water to the work area. Although jet grouting, the major method of construction for anchored soil seawall structure, has the potential for uncured concrete materials to enter nearshore waters and raise pH, it is intended to be fully contained and prevented from impacting surrounding areas (see Wang et al. 1998; Jankaite and Vasareviccaroniusa 2005). The construction water would be managed and prevented from moving into the nearshore where it could have the potential to adversely impact aquatic communities including algae, invertebrates, fish, marine mammals, and birds by temporarily exceeding water quality standards. This would likely keep adverse effects moderate and short term. However, if construction water is not managed properly upland of the temporary containment wall and allowed to move into the nearshore, it could result in a large, short-term adverse effect on the local environment.

Pile installation would also occur behind the containment wall but still in the water to install a pile-supported sidewalk; estimated that up to 175 new concrete piles may be installed. Noise from piles that will be installed landward of the containment wall is anticipated to be attenuated by the containment wall. Substrate-produced sound waves, which are sound waves that penetrate up through the ground from upland pile installation near the water line, have been observed extending up to 150 feet into the water column during studies at Vashon Island's ferry terminal. Studies have shown, however, that although disturbance and temporary displacement of aquatic species would likely occur from the transmission of sound to the aquatic environment, mortality of highly mobile species such as fish, birds, and marine mammals is unlikely (see Laughlin 2006). Employing vibratory hammers whenever possible, as discussed above, would help reduce the noise levels in the nearshore and thus, the impacts. If

necessary, sound attenuation techniques may be used to help additionally reduce construction noise (see Reyff 2003).

In Alternative A, the only substantial exceptions to construction activities being restricted to behind the existing seawall are in Zones 1 and 3. In Zone 1, the existing wall would be removed before the new wall is installed as the new wall is in exactly the same location as the existing wall. In Zone 3, the new seawall structure would be installed behind the existing structure with a new wall face installed on the waterward side of the existing seawall, resulting in the new seawall set three feet waterward. However, as in other zones, a temporary containment wall would be placed waterward of all seawall construction operations. The construction and installation of the new seawall, therefore, would occur in an area currently occupied by nearshore habitat, eliminating the biological resources in the area (approximately 3,000 square feet). Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) would likely be killed by the action. Although removal of some individuals is likely, marine nearshore habitats have been shown to be resilient after major disturbances and can become reestablished fairly quickly under moderately favorable conditions (see Dernie et al. 2003). The use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15), deploying silt curtains to contain re-suspended sediments, and having an on-site monitor present during construction, would help reduce detrimental effects. It should be noted that this action would only have detrimental effects during construction, which would end following the completion of the new seawall in Zone 3. With use of BMPs, the impact from construction of the new seawall in the nearshore of Zone 3 is anticipated to be short term and moderate.

5.3.3 Upland Construction

Effects to the upland environment associated with the Alternative A seawall replacement are diverse but generally not substantial, which is an expected outcome due primarily to the already degraded urban upland environment currently present in the study area. Effects would come from construction activities creating loud noises and disruptive motions that would likely disturb and displace urban-adapted upland wildlife (primarily urban-adapted birds, including exotics which are not protected under the Migratory Bird Treaty Act [16 U.S.C. 703-712], and a limited number of native species). Actions that are expected to create disturbances include the removal and replacement of the existing seawall in Zones 1, 2, 4, 5 and 6, as well as the excavation required for its landward relocation, the restoration of sidewalks and Alaskan Way, and construction of various public spaces. The removal of existing habitat such as ornamental trees and planters due to construction would reduce the minimal available habitat in the area.

Unlike Alternative B and to some extent Alternative C, Alternative A requires less excavation due to the minor seawall setback, which would likely result in less disturbance and existing habitat being removed. Although disturbance effects are scheduled to last through the duration of construction, they are anticipated to be periodic and not add substantially to what is already a highly disturbed urban environment. Furthermore, since the existing conditions of the urban environment currently hosts an abbreviated upland community of which most species are exotic and/or common and adapted to

anthropogenic conditions, construction disturbance and removal of existing habitat are not expected to impact their populations.

The disturbance to birds, the only wildlife taxa with significant numbers in the upland area, would likely be the most substantial (see Laughlin 2006). Noise and other disturbances from construction activities would undoubtedly displace birds from the area. Because construction is slated to occur for up to nine months each year over multiple years, migrants as well as wintering and breeding birds are likely to be impacted. However, most birds are non-breeders and would not necessarily have biological needs unique to the study area. If birds are displaced by construction, they would move from the area with little direct impact. It would be important to ensure that no native migratory birds are hurt or are killed due to construction activities as it would violate the provisions of the Migratory Bird Treaty Act.

Disturbance to other upland wildlife such as rodents would likely also occur, however, these species are primarily non-native and assumed to be well adapted to the anthropogenic disturbance in the area. No federal or state listed upland species are expected to be impacted by the seawall replacement.

Many upland plants in the project area would likely be removed during construction. Most of these plants, however, are ornamentals and provide little natural-type habitat and support few native species. Furthermore, the limited upland habitat enhancements planned under Alternative A would replace and augment existing vegetation with native species (i.e., riparian plantings) that would be placed in areas more appropriate for ecosystem support; however, the extent would be less than in Alternative B and somewhat less than Alternative C. BMPs (see Section 5.6) such as minimizing disturbance whenever possible and having an on-site observer present during the removal of existing habitat features could further decrease detrimental impacts, and proposed habitat enhancements would improve natural habitat conditions over existing conditions. With use of BMPs, the impact of construction on the upland environment landward of the temporary containment wall is anticipated to be short term and moderate, and ultimately offset by associated habitat enhancements.

5.3.4 Habitat Enhancement Related Construction

Detrimental impacts to the nearshore environment from the installation and construction of habitat enhancement features are expected to cause disturbance and bury some existing habitats but overall are not substantial. Actions such as placement of confined fill habitat benches (Zones 2, 3, 4, 5, and 6), subtidal substrate enhancements (Zones 1, 4, and 6), subtidal reef and aquatic vegetation (Zones 1, 4, and 6), habitat benches between piers (Zones 4 and 6), and a boulder seawall toe (Zone 1) would all be considered in-water work. As with seawall replacement actions slated to occur in the nearshore, the construction of habitat enhancement features would also have the potential to disturb and re-suspend sediments and associated pollutants including PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [SDOT 2012a] for details), potentially increasing their bioavailability to fish and wildlife. Actions such as minor excavation of existing substrate to facilitate placement of materials and the actual placement of benches, reefs, and gravel/shell hash would result in the disturbance and temporary displacement of marine species. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels),

marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) would likely be buried and killed by the action. However, marine nearshore habitats have been shown to be resilient after major disturbances, such as from large storms, and can reestablish quickly (see Dernie et al. 2003). Additionally, the in-water work window from August 1 to February 15 (to be further refined in coordination with regulatory agencies) would dictate most work to occur in the fall and winter when densities of listed salmonids would be at their lowest and marine plants would be seasonally senescing.

During construction, upland species would also likely be disturbed and leave the area due to construction noise and activities but would not be harmed. Habitat enhancement construction in upland areas is not expected to affect the existing environment and wildlife beyond a short-term disturbance from construction activities.

A secondary effect of the placement of fill for all of these features is that placement of new clean substrate would bury existing sediments, reducing the potential for disturbance and resuspension by future events. This benefit would not only provide its intended habitat enhancement function, but it would also improve the nearshore through the isolation of some areas of existing contaminated substrate.

The use of BMPs (see Section 5.6) during construction such as only working in the approved work window for salmonids (August 1 to February 15), placing clean substrate materials (minimize fines), and using silt curtains to contain re-suspended sediments, could reduce potential detrimental effects. Detrimental effects from this action are expected to only be temporary. With the use of appropriate BMPs, the impact from the construction of habitat enhancements is therefore, anticipated to be at most, short term and moderate.

5.3.5 Other Construction Improvements

In addition to the habitat features described above, Alternative A would include restoring or replacing Washington Street Boat Landing. As with other in-water construction activities of this alternative, installation of new landing support pilings and other features would be in-water work and could cause short-term, localized turbidity that would likely temporarily re-suspend substrate contaminants in nearshore waters. The driving of piles would also likely disturb and displace marine species such as fish and mammals as well as birds. Pile installation or removal, if not properly managed to reduce detrimental environmental effects (see Section 5.2), has the potential to harm or kill individual fish, including juvenile salmonids that are present in the immediate area. Construction over or near the nearshore increases the risk for inadvertent spills or leaks of toxic construction materials such as paint or solvents, and/or inadvertent deposition of solid waste and construction debris into the water. Attenuating sound waves from pile driving using available techniques, if applicable, or strategically timing the actions to reduce the potential for impacting sensitive species, would help reduce negative effects. Reducing the resuspension of sediment to whatever extent possible and properly managing construction materials would help reduce short-term detrimental impacts from construction.

5.3.6 Construction Summary of Effects

Overall, the construction effects from the proposed seawall replacement presented for Alternative A are expected to be short term and moderate as a result of in-water work for the removal of riprap and installation of the temporary containment wall, and the installation of Washington Street Boat Landing. The majority of construction, however, would be isolated from Elliott Bay or restricted to upland areas that are already substantially degraded by urbanization, and the habitat enhancements that are slated as part of the design would ultimately reduce detrimental impacts. Although the effects from the proposed seawall replacement presented for Alternative A would be periodic and occur throughout the duration of construction, negative effects would not last beyond project completion and would be considered short term.

5.4 ALTERNATIVE B

Alternative B employs a BSP seawall structure but soil improvement or buttress fill systems (see Section 1.6.3) could also be substituted and still maintain the wall location, habitat improvements, and other proposed features. However, in the case where Alternative B construction methods incorporate other structural options, effects related to the substituted options would apply. In all cases under Alternative B, the new seawall would be constructed behind the existing seawall which would be removed as needed. As a result, the majority of seawall-related construction would likely be considered upland work, substantially reducing the potential for negative effects on the nearshore. Limited in-water work, however, would still be required to complete this alternative.

In all cases in Alternative B, the construction sequence requires the same three in-water work actions that are slated to occur in the nearshore as described for Alternative A. The first in the sequence is the removal or displacement of some of the riprap currently placed at the toe of the existing seawall, second is the placement and removal of a temporary containment wall, and third is the installation of in-water habitat features.

In general, Alternative B shares the same effects as Alternatives A and C; however, the greater seawall pull back and increased number and scope of habitat enhancements are expected to require more and lengthier construction activities.

5.4.1 Installation and Removal of Temporary Containment Wall

The installation and removal of the temporary containment wall requires three major actions: the removal or displacement of riprap, placement of a sheet-pile wall in the nearshore that would remain for one to two construction seasons, and the removal of the sheet-pile wall. Various disturbances to the nearshore marine environment and upland environment would likely result from these actions as described in this section, causing impacts to the biological resources in the area.

The removal or displacement of some riprap is necessary to access the substrate for installation of additional construction elements including the temporary containment wall. Originally, the riprap was installed for protection and stabilization of the seawall. Over time, movement of the riprap has occurred due to processes such as sinking, wave and tidal action, requiring subsequent placement of additional riprap to maintain the required protection. Sediments adjacent to the riprap in various locations along

the seawall are known to contain low to moderate levels of various pollutants such as PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [SDOT 2012a] for details on specific locations). Together, these past actions have resulted in a large amount of riprap to be present along the majority of the length of the existing seawall. Because the removal of riprap would take place waterward of the existing seawall, it would be considered in-water work. Effects from this action, therefore, are anticipated to be detrimental to the nearshore environment. The removal of riprap would likely disturb and at least partially re-suspend sediments and pollutants in the water column where they could be redistributed in the nearshore through tidal and wave action. Recent video from nearshore surveys (SDOT 2011; Anchor QEA 2012), however, have suggested sediment resuspension from disturbance to be minimal to moderate (sand/silt/shell hash mixed sediments re-suspend, but settle quickly). Regardless, any resuspension of pollutants may increase the potential for transfer of contaminants to the water column or to marine organisms including some listed species such as salmonids. The disturbance caused by the proposed action (i.e., noise, vibration, movement, etc.) would likely, at a minimum, alter the behavior of fish and wildlife near the action area, including marine mammals, causing them to flee the area if mobile. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) could be injured or killed directly by the action, or from exposure due to remaining attached to the excavated riprap. Upland species would also likely be disturbed and leave the area. Because this action is slated to occur throughout the nearshore of the project area, the effects would occur along the entire length of the wall. However, the use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15) and using silt curtains to contain re-suspended sediments would reduce the negative impact. It should also be noted that this action would only have a short-term effect and once complete, the riprap would be removed off site or reused in habitat features. With use of BMPs, the impact from the removal of riprap in the nearshore environment is therefore, anticipated to be short term and moderate.

Following riprap removal, a temporary containment wall likely constructed of sheet pile, would be installed in each construction segment waterward of the existing seawall and would remain for one to two construction seasons, after which, it would be removed. The purpose of the temporary containment wall is to isolate construction areas from the nearshore and prevent sediment and water quality contaminants from degrading Elliott Bay. Following installation, the area landward of the temporary containment wall would be considered “isolated” and work could continue outside of the designated in-water work window. Construction sequence is slated to have the temporary containment wall installed in each construction work zone during a different year; however, over the duration of the project, the entire length of the seawall (approximately 6,328 feet) would have the temporary containment wall installed and removed at some point. It is estimated that 1,738 sheet-pile segments in total would need to be installed and then removed in this effort. Although the temporary containment wall would function as a barrier intended to isolate the area of construction from the nearshore environment, the location of its installation on the waterward side of the existing seawall would be considered in-water work.

As with the removal of riprap, the installation of the temporary containment wall would likely disturb sediments and associated contaminants, potentially causing their resuspension in the nearshore. In addition, machinery and techniques that would likely be used to install sheet pile such as vibratory and impact hammers, are known to disturb or in extreme instances, kill organisms such as fish found in close proximity (see Feist et al. 1992; Turnpenny et al. 1994; summarized in Popper and Hastings 2009). Upland species would also likely be disturbed by this action and associated noise (see Laughlin 2006). The use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15), working during low tides, restricting use of impact hammers to only when necessary, and deploying silt curtains to contain re-suspended sediments, (see Reyff 2003), would reduce negative effects. It should also be noted that this action would only have temporary effects during the installation and removal of the temporary containment wall, but would not substantially impact the nearshore once the sheet pile is in place or once removed. With use of BMPs, the impact from the installation and removal of the temporary containment wall in the nearshore environment is therefore, anticipated to be short term and moderate.

5.4.2 Seawall Pullback and Construction

All construction is slated to occur behind the temporary containment wall in areas that are currently upland and occupied by the existing seawall and infill supporting the sidewalk and Alaskan Way. The purpose of the temporary containment wall is to confine construction activities to areas landward of the nearshore and restrict sediment and water quality contaminants from entering Elliott Bay. In addition, the existing seawall would remain in place through most of construction in all zones to further enhance this barrier. Since the majority of the proposed construction is slated to be in areas that are currently upland and would be physically separated from the nearshore by the temporary containment wall and existing seawall, it would likely be considered upland work.

Excavation required for the wall pullback would occur landward of the temporary containment wall and only in urban upland areas. This would minimize direct adverse effects to natural-type habitat, as virtually none currently exists landward of the nearshore in the proposed project area. Disturbance is expected to occur to upland wildlife that currently reside in the area, however, none are protected species and all are mobile and are expected to move from the area unharmed. The substantial net increase in aquatic habitat would provide a long-term benefit that would largely reduce potential adverse effects from any loss of existing habitat or temporary disturbance to existing wildlife. Alternative B is slated to require more excavation than Alternative A or C due to the greater seawall pullback and much larger habitat enhancement scope, and would likely have more adverse effects; however, the difference would not likely be substantial. Excavation would have a short-term and minor effect on the biological resources in the study area. Although excavation would expose existing CSO and stormwater outfalls and their associated infrastructure, they would be managed to retain their function during and after the proposed construction and would be left generally in their current location (ends of pipes would need adjusting following wall set back).

Following the initiation of excavation behind the temporary containment wall, it is assumed that water would move into the work area from various sources including rain, groundwater, tidal fluctuations, and construction sources, and mix with and mobilize contaminated sediments. The temporary containment

wall and existing seawall structure are intended to work in tandem to restrict this construction water to the work area. Construction water would be managed and prevented from moving into the nearshore where it could have the potential to adversely impact aquatic communities including algae, invertebrates, fish, marine mammals, and birds by temporarily exceeding water quality standards. This would likely keep adverse effects moderate and short term. However, if construction water is not managed properly upland of the temporary containment wall and allowed to move into the nearshore, it could result in a large, short-term, adverse effect on the local environment.

Auguring in the steel casings is a large component of the BSP structure but would entirely occur landward of the temporary containment wall and existing seawall. As stated in Section 5.2, installation of piles in uplands will not generate in-water noise impacts that are typically associated with pile installation. With use of appropriate BMPs (see Section 5.6), the impact from the construction behind the temporary containment wall on the nearshore environment is therefore, anticipated to be at the most, short term and minor.

5.4.3 Upland Construction

Effects to the upland environment associated with the Alternative B seawall replacement are diverse but generally not substantial, which is an expected outcome due primarily to the already degraded urban upland environment currently present in the study area. Effects would likely come from construction activities that would cause loud noises and disruptive motions which would likely disturb and displace urban-adapted upland wildlife (primarily urban-adapted birds, including exotics which are not protected under the Migratory Bird Treaty Act, and a limited number of native species). Actions that are expected to create disturbances include the removal and replacement of the existing seawall in all zones as well as the excavation required for its landward relocation, the restoration of sidewalks and Alaskan Way, and construction of various public spaces. The removal of existing habitat such as ornamental trees and planters due to construction would reduce the minimal available habitat in the area.

Alternative B requires more excavation than Alternative A and C due the longer seawall setback and increased scope for habitat enhancement, which would likely result in more disturbance and existing habitat being removed. Although disturbance effects are scheduled to last through the duration of construction, they are anticipated to be periodic and not add substantially to what is already a highly disturbed urban environment. Furthermore, since the existing conditions of the urban environment currently hosts an abbreviated upland community of which most species are exotic and/or common and adapted to anthropogenic conditions, construction disturbance and removal of existing habitat are not expected to impact their populations.

The disturbance to birds, the only wildlife taxa with significant numbers in the upland area, would likely be the most substantial (see Laughlin 2006). Noise and other disturbances from construction activities would undoubtedly displace birds from the area. Because construction is slated to occur up to nine months each year over multiple years, migrants as well as wintering and breeding birds are likely to be impacted. However, most birds are non-breeders and would not necessarily have biological needs unique to the study area. If birds are displaced by construction, they would move from the area with

little direct impact. It would be important to ensure that no native migratory birds are hurt or killed due to construction activities as it would violate the provisions of the Migratory Bird Treaty Act.

Disturbance to other upland wildlife such as rodents would likely also occur, however, these species are primarily non-native and assumed to be well adapted to the anthropogenic disturbance in the area. No federal or state listed upland species are expected to be impacted by the seawall replacement.

Many upland plants in the project area would likely be removed during construction. Most of these plants, however, are ornamentals and provide little natural-type habitat and support few native species. Furthermore, habitat enhancements planned under Alternative B would replace and substantially augment existing vegetation with native species that would be placed in areas more appropriate for ecosystem support. These habitat enhancements would be larger in scope than they would be for Alternative A and C, increasing the net gain in environmental benefit. BMPs (see Section 5.6) such as minimizing disturbance whenever possible and having an on-site observer present during the removal of existing habitat features would further decrease detrimental impacts, and proposed habitat enhancements would improve natural habitat conditions over existing conditions. With use of BMPs, the impact of construction on the upland environment landward of the temporary containment wall is anticipated to be short term and moderate and ultimately negated by associated habitat enhancements.

5.4.4 Habitat Enhancement Related Construction

Detrimental impacts to the nearshore environment from the installation and construction of habitat enhancement features are expected to be primarily from disturbance and burying of existing sediments, but overall are not substantial. Actions such as placement of confined fill habitat benches (Zones 2, 3, 4, 5 and 6), subtidal substrate enhancements (Zones 1, 4 and 6), subtidal reef and aquatic vegetation (Zones 1, 4 and 6), and habitat benches between piers (Zones 4 and 6) would all be considered in-water work. As with seawall replacement actions slated to occur in the nearshore, the construction of habitat enhancement features would also have the potential to disturb and re-suspend sediments and associated pollutants including PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [SDOT 2012a] for details), potentially increasing their bioavailability to fish and wildlife. Actions such as excavation of existing substrate to facilitate placement of benches and the actual placement of benches, reefs, and gravel/shell hash, would result in the disturbance and temporary displacement of marine species. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow moving species (e.g., starfish and crabs) would likely be buried and killed by the action. However, marine nearshore habitats have been shown to be resilient after major disturbances, such as major storms, and can become reestablished fairly quickly under favorable conditions (see Dernie et al. 2003) such as would be present following construction. Additionally, the in-water work window from August 1 to February 15 (to be further refined in coordination with regulatory agencies) would dictate most work to occur in the fall and winter when densities of listed salmonids would be at their lowest and marine plants would be seasonally senescing.

During construction, upland species would also likely be disturbed and leave the area due to construction noise and activities but would not be harmed. Habitat enhancement construction in upland areas is not expected to effect the existing environment and wildlife beyond a short-term disturbance from construction activities.

A secondary effect of the placement of fill for all of these features is that placement of new clean substrate would likely cover existing sediments, reducing the potential for disturbance and resuspension from future events. This benefit would not only provide its intended habitat enhancement function, but it would also improve the nearshore through the isolation of some areas of existing contaminated substrate.

The use of BMPs (see Section 5.6) during construction such as only working in the approved work window for salmonids (August 1 to February 15) or an approved extension to the in-water work window and using silt curtains to contain re-suspended sediments, would reduce any detrimental effects that would occur. Detrimental effects from this action are expected to only be periodic and temporary. With use of appropriate BMPs, the impact from the construction of habitat enhancements is therefore, anticipated to be at most, short term and moderate.

5.4.5 Other Construction Improvements

Other construction improvements associated with Washington Street Boat Landing would generally be the same under Alternative B as with Alternative A. The only potential exception would be the construction of a new gangway and short-stay boat moorage intended to restore historic function to this landing. These added features would likely require additional support piles to be driven into the nearshore. However, it is assumed that only a small number of additional piles would need to be used in for this effort. Because the extent of in-water work for this action would largely be comparable to those presented in Alternative A and Alternative C, construction effects and mitigation would also likely be comparable.

5.4.6 Construction Summary of Effects

Overall, the construction effects from the proposed seawall replacement presented for Alternative B are expected to be short term and moderate as a result of in-water work for the removal of riprap and installation of the temporary containment wall and the installation of Washington Street Boat Landing and associated boat moorage. The majority of construction, however, would be isolated from Elliott Bay or restricted to upland areas that are already substantially degraded by urbanization, and the habitat enhancements that are slated as part of the design would help reduce detrimental impacts. Although the effects from the proposed seawall replacement presented for Alternative B would be periodic and occur throughout the duration of construction, most negative effects would not last beyond project completion and would be considered short term.

5.5 ALTERNATIVE C

Alternative C proposes a soil improvement seawall structural option but a BSP structural option (see Section 1.6.3) could be used and still maintain the wall location, habitat improvements and other

proposed features. If Alternative C construction methods incorporate other structural options such as the BSP structural option, effects related to the substituted options would apply. In all zones under Alternative C, the new seawall would be constructed behind (i.e., landward of) the existing seawall which would be removed as needed. As a result, the majority of seawall-related construction would likely be considered upland work, substantially reducing the potential for negative effects on the nearshore. Limited in-water work, however, would still be required to complete this alternative.

In most cases in Alternative C, the construction sequence requires the same three in-water work actions that are slated to occur in the nearshore as described for Alternatives A and B. The first in the sequence is the removal or displacement of some of the riprap currently placed at the toe of the existing seawall; the second is the placement and removal of a temporary containment wall; and the third is the installation of in-water habitat features.

In general, Alternative C would incur the same effects as Alternatives A and B; however, its intermediate seawall pull back and number and scope of habitat enhancements are expected to require more and lengthier construction activities than Alternative A but less than Alternative B.

5.5.1 Installation and Removal of Temporary Containment Wall

Following riprap removal, a temporary containment wall likely constructed of sheet pile would be installed in each construction segment waterward of the existing seawall and would remain for one to two construction seasons, after which it would be removed. The installation and removal of the temporary containment wall requires three major actions: the removal or displacement of riprap, placement of a sheet-pile wall in the nearshore for one or two construction seasons, after which it would be removed. Various disturbances to the nearshore marine environment and upland environment would likely result from these actions as described in this section, causing impacts to the biological resources in the area.

The removal or displacement of some riprap is necessary to access the substrate for installation of additional construction elements including the temporary containment wall. Originally, the riprap was installed for protection and stabilization of the seawall. Over time, movement of the riprap has occurred due to processes such as sinking, wave and tidal action; thus requiring subsequent placement of additional riprap to maintain the required protection. Together, these past actions have resulted in a large amount of riprap to be present along the majority of the length of the existing seawall. Because the removal of riprap would take place waterward of the existing seawall, it would be considered in-water work. Effects from this action, therefore, are anticipated to be detrimental to the nearshore environment.

Sediments adjacent to the riprap are known to contain low to moderate levels of various pollutants such as PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [SDOT 2012a] for details on locations). The removal of riprap would likely disturb and at least partially re-suspend sediments and pollutants in the water column where they could be redistributed in the nearshore through tidal and wave action. Recent video from nearshore surveys (SDOT 2011; Anchor QEA 2012), however, have suggested sediment resuspension from disturbance to

be minimal to moderate (sand/silt/shell hash mixed sediments re-suspend, but settle quickly). Regardless, any resuspension of pollutants may increase the potential for transfer of contaminants to the water column or to marine organisms including some listed species such as salmonids. The disturbance caused by the proposed action (i.e., noise, vibration, movement, etc.) would likely, at a minimum, alter the behavior of fish and wildlife near the action area, including marine mammals, causing them to flee the area, if mobile. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) could be hurt or killed directly by the action, or from exposure due to remaining attached to the excavated riprap. Upland species would also likely be disturbed and leave the area. Because this action is slated to occur throughout the nearshore of the project area, the effects would occur along the entire length of the wall. However, the use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 1 to February 15) or an approved extension to the work window and using silt curtains to contain re-suspended sediments would minimize the negative impact. It should also be noted that this action would only have a short-term effect and once complete, the riprap would be removed off site or reused in habitat features. With use of BMPs, the impact from the removal of riprap in the nearshore environment is therefore, anticipated to be short term and moderate.

Following riprap removal, a temporary containment wall likely constructed of sheet pile would be installed in each construction segment waterward of the existing seawall and would remain for one to two construction seasons, after which, it would be removed. The purpose of the temporary containment wall is to isolate construction areas from the nearshore during demolition and excavation activities and, along with a containment curtain, would prevent sediment and water quality contaminants from degrading Elliott Bay. The construction sequence is intended to have the temporary containment wall installed in each construction work zone during a different year; however, over the duration of the project, the entire length of the seawall (approximately 6,328 feet) would have the temporary containment wall installed and removed at some point. It is estimated that 1,738 sheet-pile segments in total would need to be installed and then removed in this effort. Although the temporary containment wall and curtain would function as a barrier intended to isolate the area of construction from the nearshore environment, the actual installation and removal on the waterward side of the existing seawall would be considered in-water work.

As with the removal of riprap, the installation of the temporary containment wall and containment curtain would likely disturb sediments and associated contaminants, potentially causing their resuspension in the nearshore. In addition, machinery and techniques that would likely be used to install sheet pile such as vibratory and impact hammers, are known to disturb or in extreme instances, kill organisms such as fish found in close proximity (see Feist et al. 1992; Turnpenny et al. 1994; summarized in Popper and Hastings 2009). Upland species would also likely be disturbed by this action and associated noise (see Laughlin 2006). The use of BMPs (see Section 5.6) such as only working in the approved work window for salmonids (August 15 to February 15) or an approved extension to the in-water work window, working during low tides, restricting use of impact hammers to only when necessary, deploying silt curtains to contain re-suspended sediments, and if appropriate using sound attenuation devices (see Reyff 2003), would reduce negative effects. It should also be noted that this

action would only have temporary effects during the installation and removal of the temporary containment wall, but would not substantially impact the nearshore once the sheet pile is in place or once removed. With the use of BMPs, the impact from the installation and removal of the temporary containment wall in the nearshore environment is therefore, anticipated to be short term and moderate.

5.5.2 Seawall Pullback and Construction

All seawall construction is slated to occur behind the temporary containment wall in areas that are currently upland and occupied by the existing seawall and infill supporting the sidewalk and Alaskan Way. The purpose of the temporary containment wall is to confine construction activities to areas landward of the nearshore and restrict the materials, equipment, activities, and wastes to that area. In addition, the existing seawall would remain in place through most of construction in all zones to further enhance this barrier. Since the majority of the proposed construction is slated to be in areas that are currently upland and would be physically separated from the nearshore by the temporary containment wall and existing seawall, it would likely be considered upland work.

Excavation required for the wall pullback would occur landward of the temporary containment wall and only in urban upland areas. This would minimize direct adverse effects to natural-type habitat, as virtually none currently exists landward of the nearshore in the proposed project area. Disturbance is expected to occur to upland wildlife that currently reside in the area, however, none are protected species and all are mobile and are expected to move from the area unharmed. The net increase in aquatic habitat would provide a long-term benefit that would largely reduce potential adverse effects from any loss of existing habitat or temporary disturbance to existing wildlife. Alternative C is slated to require more excavation than Alternative A but less than Alternative B due its intermediate seawall pullback and habitat enhancement scope. It is therefore expected that Alternative C would have adverse effects intermediate between the two other build alternatives; however, the differences would not likely be substantial. Excavation would have a short-term and minor effect on the biological resources in the study area. Although excavation would expose existing CSO and stormwater outfalls and their associated infrastructure, they would be generally protected in place and managed to retain their function during and after the proposed construction and would be left generally in their current location (ends of pipes would need adjusting following wall set back). The loadings of pollutants in urban stormwater runoff are expected to be reduced in project site runoff discharges to Elliott Bay as compared to the existing condition.

Following the initiation of excavation behind the temporary containment wall, it is assumed that water would move into the work area from various sources including rain, groundwater, tidal fluctuations, and construction sources, and mix with and mobilize contaminated sediments. The temporary containment wall, curtain, and existing seawall structure are intended to work in tandem to restrict this construction water to the work area. Construction water would be managed and prevented from moving into the nearshore where it could have the potential to adversely impact aquatic communities and species by temporarily exceeding water quality standards. This would likely keep adverse effects moderate and short term. However, if construction water is not managed properly upland of the temporary containment wall and spills into the nearshore, it could result in a large, short-term, adverse effect on

the local environment. Pile driving would behind the containment wall and would be in-water behind the wall to install a pile-supported sidewalk; estimated that 175 new piles may be installed. Studies have shown, however, that although disturbance and temporary displacement of aquatic species would likely occur from the transmission of sound to the aquatic environment, mortality of highly mobile species such as fish, birds, and marine mammals is unlikely (see Laughlin 2006). Employing vibratory hammers whenever possible, as discussed above, would help reduce the noise levels and thus, the impacts. If necessary, sound attenuation techniques may be used to help additionally reduce construction noise (see Reyff 2003).

5.5.3 Upland Construction

Effects to the upland environment associated with the Alternative C seawall replacement are diverse but generally not substantial, which is an expected outcome due primarily to the already degraded urban upland environment currently present in the study area. Effects would likely come from construction activities that would cause loud noises and disruptive motions which would likely disturb and displace urban-adapted upland wildlife (primarily urban-adapted birds, including exotics which are not protected under the Migratory Bird Treaty Act, and a limited number of native species). Actions that are expected to create disturbances include the removal and replacement of the existing seawall in all zones as well as the excavation required for its landward relocation, the restoration of sidewalks and Alaskan Way, and construction of various public spaces. The removal of existing habitat such as ornamental trees and planters due to construction would reduce the minimal available habitat in the area.

Alternative C requires more excavation than Alternative A but less than Alternative B due to the proposed intermediate seawall setback and scope for habitat enhancement. It is expected that the level of disturbance and amount of existing habitat removed to also be intermediate between the other two build alternatives. Although disturbance effects are scheduled to last through the duration of construction, they are anticipated to be periodic and not add substantially to what is already a highly disturbed urban environment. Furthermore, since the existing conditions of the urban environment currently hosts an abbreviated upland community of which most species are exotic and/or common and adapted to anthropogenic conditions, construction disturbance and removal of existing habitat are not expected to impact their populations.

The disturbance to birds, the only wildlife taxa with significant numbers in the upland area, would likely be the most substantial (see Laughlin 2006). Noise and other disturbances from construction activities would undoubtedly displace birds from the area. Because construction is slated to occur up to nine months each year over multiple years, migrants as well as wintering and breeding birds are likely to be impacted. However, most birds are non-breeders and would not necessarily have biological needs unique to the study area. If birds are displaced by construction, they would move from the area with little direct impact. It would be important to ensure that no native migratory birds are hurt or killed due to construction activities as it would violate the provisions of the Migratory Bird Treaty Act.

Disturbance to other upland wildlife such as rodents would likely also occur, however, these species are primarily non-native and assumed to be well adapted to the anthropogenic disturbance in the area. No federal or state listed upland species are expected to be impacted by the seawall replacement. Many

upland plants in the project area would likely be removed during construction. Most of these plants, however, are ornamentals and provide little natural-type habitat and support few native species. Furthermore, habitat enhancements planned under Alternative C would replace and augment existing vegetation with native species that would be placed in areas more appropriate for ecosystem support. These habitat enhancements would be larger in scope than they would be for Alternative A but smaller than for Alternative B. The net gain in environmental benefit would therefore be higher than that provided by Alterative A but lower than Alternative B. BMPs (see Section 5.6) such as minimizing disturbance whenever possible and having an on-site observer present during the removal of existing habitat features would further decrease detrimental impacts, and proposed habitat enhancements would improve natural habitat conditions over existing conditions. With use of BMPs, the impact of construction on the upland environment landward of the temporary containment wall is anticipated to be short term and moderate and ultimately negated by associated habitat enhancements.

5.5.4 Habitat Enhancement Related Construction

Detrimental impacts to the nearshore environment from the installation and construction of habitat enhancement features are expected to cause disturbance and bury some existing habitats but overall are not substantial. Actions such as placement of confined fill habitat benches (Zones 2, 3, 4, 5, and 6), subtidal substrate enhancements (Zones 1, 4, and 6), subtidal aquatic vegetation (Zones 1, 4, and 6), and larger habitat benches between piers (Zones 1, 4 and 6) would all be considered in-water work. As with seawall replacement actions slated to occur in the nearshore, the construction of habitat enhancement features would also have the potential to disturb and re-suspend sediments and associated pollutants including PAHs: benzo(a)pyrene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, or pyrene, and metals: arsenic, cadmium, copper, lead, mercury, silver or zinc (see the Contaminated Materials Discipline Report [2011c] for details on locations), potentially increasing their bioavailability to fish and wildlife. Actions such as minor excavation of existing substrate to facilitate placement of materials and the actual placement of benches and gravel/shell hash would result in the disturbance and temporary displacement of marine species. Organisms not able to flee from the area such as benthic invertebrates (e.g., barnacles and mussels), marine plants (e.g., sea lettuce and rockweed), and slow-moving species (e.g., starfish and crabs) would likely be buried and killed by the action. However, marine nearshore habitats have been shown to be resilient after major disturbances, such as from large storms, and can reestablish quickly (see Dernie et al. 2003). Additionally, the in-water work window from August 1 to February 15 or an approved extension would dictate most work to occur in the fall and winter when densities of listed salmonids would be at their lowest and marine plants would be seasonally senescing.

During construction, upland species would also likely be disturbed and leave the area due to construction noise and activities but would not be harmed. Habitat enhancement construction in upland areas is not expected to affect the existing environment and wildlife beyond a short-term disturbance from construction activities.

A secondary effect of the placement of fill for all of these features is that placement of new clean substrate would cover existing sediments, reducing the potential for disturbance and resuspension by future events. This benefit would not only provide its intended habitat enhancement function, but it

would also improve the nearshore through the isolation of some areas of existing contaminated substrate.

The use of BMPs (see Section 5.6) during construction such as only working in the approved work window for salmonids (August 1 to February 15) or an approved extension of the in-water work window, placing clean substrate materials (minimize fines), placing the substrate as close to the bed as possible to minimize resuspension, and using silt curtains to contain re-suspended sediments, could reduce potential detrimental effects. Detrimental effects from this action are expected to only be temporary. With the use of appropriate BMPs, the impact from the construction of habitat enhancements is therefore, anticipated to be at most, short term and moderate.

5.5.5 Other Construction Improvements

Other construction improvements associated with Washington Street Boat Landing would generally be the same under Alternative C as with Alternative A, including the restoration and replacement of the boat landing back in the Washington Street right-of-way. This added feature would likely require additional support piles to be driven into the nearshore. However, it is assumed that only a small number of additional piles would need to be used in for this effort (up to 15). Because the extent of in-water work for this action would largely be comparable to that presented in Alternative A, construction effects and mitigation would also likely be comparable.

5.5.6 Construction Summary of Effects

Overall, the construction effects from the proposed seawall replacement presented for Alternative C are expected to be short term and moderate as a result of in-water work for the removal of riprap and installation of the temporary containment wall and the installation of Washington Street Boat Landing. The majority of construction, however, would be isolated from Elliott Bay or restricted to upland areas that are already substantially degraded by urbanization, and the habitat enhancements that are slated as part of the design would help reduce detrimental impacts. Although the effects from the proposed seawall replacement presented for Alternative C would be periodic and occur throughout the duration of construction, most negative effects would not last beyond project completion and would be considered short term.

5.6 MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

A variety of conservation measures and BMPs will be implemented prior to or during construction to reduce the potential for direct and indirect effects to ESA-listed species and their critical habitats. These measures are designed to reduce or eliminate disturbance, turbidity, resuspension of contaminants, removal of biota, noise, debris falling into the water, and fish stranding. Elements of the design that will provide long-term benefits to listed and proposed species include the habitat measures and the addition of stormwater treatment for the restored roadway.

- BMPs that will be employed during construction include: Confine in-water work activities to the designated work windows when the fewest ESA-listed species are present, except for the proposed extension as described above.

- Install a temporary containment wall to isolate Elliott Bay from the construction work zone to reduce turbidity, resuspension of contaminants, and any potential for concrete (pH) leaching.
- Leave the final segment of the containment wall open to first sweep with nets to push fish out into Elliott Bay beyond the wall prior to fully closing to reduce fish stranding and reduce fish handling to reduce fish stranding.
- Comply with water quality monitoring requirements (such as from Water Quality Certification) for turbidity, pH, etc.
- Develop and implement a stormwater pollution and prevention plan (SWPPP) and construction stormwater and erosion control plan (CSECP) during construction.
- Temporarily dewater behind containment wall as feasible (or conduct at low tide) and conduct fish salvage behind the containment wall per an authorized Scientific Collection Permit and release fish out into Elliott Bay beyond the wall.
- Consider use of silt curtains as necessary (or if monitoring of construction activities indicates potential exceedances of water quality standards) when conducting in-water work to reduce turbidity and resuspension of contaminated sediments (i.e., during riprap removal/displacement, installation of temporary containment wall, and placement of habitat features).
- Treat stormwater and process water runoff from the construction zones prior to discharge to either Elliott Bay or the King County sewer system.
- Minimize the removal of riprap to avoid removing associated biota, reduce turbidity, and avoid resuspension of contaminants.
- Employ vibratory pile-driving equipment to reduce sound levels to below fish-injury thresholds and use sound attenuation measures, as feasible, for impact driving of concrete piles and the limited number of impact-proofed sheet piles.
- Employing noise attenuation techniques would reduce sound energy from pile-related activities to some extent. Constraints of the project area prevent bubble curtains and the dewatering of in-water construction areas from being used. Contaminated sediments would likely be resuspended by bubble curtains and tidal actions and limits of hardware and techniques would make dewatering the area behind a coffer dam and within a containment sleeve difficult. Unfortunately, use of bubble curtains and the dewatering of areas where pile manipulations would take place have shown to be the most effective noise attenuating methods. Employing the remaining methods, such as using cushion blocks for all impact pile installation and installing in-water piles within watered steel casings (i.e., behind a wet containment wall or within a submerged containment sleeve), would provide minor attenuation.
- Monitor for the presence of marine mammals and follow MMPA authorization requirements for temporary shutdowns when any marine mammals enter the exclusion zone, or other measures.
- Install netting and/or tarping to catch any falling debris from entering the water from over-water activities (e.g., sidewalk removal and installation).

- Use only clean and coarse materials and place via bucket close to the substrate surface to minimize sediment resuspension where material will be placed in-water (e.g., habitat benches). Fill material quantities have been optimized during design to minimize fill while maximizing habitat area and function.
- The City will comply with all permit conditions issued by resource agencies for the project.

CHAPTER 6. OPERATIONAL EFFECTS AND MITIGATION

This chapter describes the anticipated post-construction effects and/or effects from the project on the biological resources from the No Action Alternative and the three build alternatives. Under the No Action Alternative, the project would not be constructed; therefore, the only operational effects would be those caused by required future maintenance and repairs if the seawall fails in part or in whole.

Also included is a discussion of measures that could be incorporated into the proposed project to avoid and minimize impacts associated with the typical elements of design presented in the EBSP build alternatives. Table 6-1 presents a summary of habitat-related enhancements proposed for Alternatives A, B and C; each plays a large role in determining the net operational effects of each alternative. The structural and roadway components of all alternatives have substantially less operational effects on biological resources than do the habitat enhancements.

TABLE 6-1. SUMMARY OF HABITAT ENHANCEMENTS BY ZONE FOR ALTERNATIVES A, B, AND C

Zone	Alternative A	Alternative B	Alternative C
1	Seawall face left in existing location	Seawall face to be placed 15 feet landward from existing location	Seawall face to be placed 10 to 15 feet landward from existing location
	Battered and textured seawall face	Textured seawall face	Textured seawall face
	Boulder seawall toe only if necessary for scour protection	Intertidal habitat bench with supratidal backshore (and potential buttress fill)	Intertidal habitat bench with supratidal backshore; boulders
	Riparian planters	Riparian plants and drift logs	Riparian plants and drift logs
	Subtidal substrate enhancements	Subtidal substrate enhancements	Subtidal substrate enhancements
	Subtidal reef and aquatic vegetation	Subtidal reef and aquatic vegetation	Subtidal aquatic vegetation
	N/A	Boulders (Option 1) or steps and boardwalk (Option 2)	Boulders
2	Seawall face placed 15 feet landward of existing location	Seawall face 15 feet landward from existing location	Seawall face 15 feet landward from existing location
	Textured seawall face	Textured seawall face with habitat shelves and fins	Textured seawall face
	LPS	LPS	LPS
	Confined fill habitat bench	Confined fill habitat bench	Confined fill habitat bench
3	Seawall face set waterward 3 feet from existing location	Seawall face 30 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location
	Textured seawall face	Textured seawall face with habitat shelves and fins	Textured seawall face
	Confined fill habitat bench (limited width)	Confined fill habitat bench	Confined fill habitat bench
	LPS	LPS	LPS
	Riparian planters	Riparian planters	Riparian planters

Zone	Alternative A	Alternative B	Alternative C
4	Seawall face 10 feet landward from existing location	Seawall face ranges from 30 to 75 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location
	Textured seawall face	Textured seawall face with habitat shelves and fins	Textured seawall face
	Habitat bench between piers	Habitat bench between piers	Habitat bench between piers
	Confined fill habitat bench along piers	Confined fill habitat bench along piers	Confined fill habitat bench along piers
	LPS	LPS	LPS
	Riparian planters	Riparian planters	Riparian planters
	Subtidal substrate enhancements	Subtidal substrate enhancements	Subtidal substrate enhancements
	Subtidal reef and aquatic vegetation	Subtidal reef and aquatic vegetation	Subtidal aquatic vegetation
	Landscape-buffer strips	Landscape-buffer strips	Landscape-buffer strips
5	Seawall face 10 to 15 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location
	Textured wall face	Textured wall face with habitat shelves and fins	Textured wall face
	Confined fill habitat bench	Confined fill habitat bench	Confined fill habitat bench
	Riparian planters	Riparian planters	Riparian planters
6	Seawall face 10 to 15 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location	Seawall face 10 to 15 feet landward from existing location
	Textured wall face	Textured wall face with habitat shelves and fins	Textured wall face
	LPS	LPS	LPS
	Habitat bench between piers	Habitat bench between piers	Habitat bench between piers
	Confined fill habitat bench along piers	Confined fill habitat bench along piers	Confined fill habitat bench along piers
	Subtidal reef and aquatic habitat	Subtidal reef and aquatic habitat	Subtidal aquatic habitat
	Subtidal substrate enhancement	Subtidal substrate enhancement	Subtidal substrate enhancement
	Riparian planters	Riparian planters	Riparian planters

Notes: LPS – light-penetrating surfaces, N/A – not applicable

6.1 NO ACTION ALTERNATIVE

Under the No Action Alternative, the EBSP would not be constructed; thus, there would be no anticipated effects beyond those caused by future maintenance and potential repairs if the seawall were to fail in part or in whole. Because details for maintenance and repairs have not been established, it can only be assumed that at a minimum, anticipated effects from these actions would include disturbance to biological resources in the action area.

The No Action Alternative would provide no environmental benefits through habitat enhancements to the biological resources in the study area; nearshore and upland habitats would remain highly urbanized, degraded, and generally lacking. The seawall structure would also not be enhanced (i.e., face panels).

In the event that one of the three No Action scenarios occurs, it can be assumed that the required repairs would result in long-term stabilization of the seawall structure. Maintenance would be required following the repair throughout the life of the restored seawall. Depending on the capacity for planning a restoration following one of the three No Action damage scenarios, habitat enhancements may be incorporated into the design. It is anticipated, however, that the urgency to stabilize and repair the seawall following a damage event would largely preclude the incorporation of environmental enhancements. If a seawall collapse scenario occurred, a large quantity of soils and debris would likely move into the bay and create additional shallow shoreline. This shoreline would likely need to be stabilized with rock or other materials and the waterfront area would likely be rebuilt to some extent. The soils that had washed into the bay could incidentally create more intertidal habitat over time. Also, it is very likely that during a partial or complete failure of the seawall that all existing utilities along the shoreline would be ruptured and stormwater, sewage, natural gas, oil tanks and other pollutants would spill or be washed into the nearshore.

In the event that any No Action scenario occurs, several detrimental operational effects are anticipated to be incurred by the biological resources in the study area:

Minimal Damage: It would be assumed that under the Minimal Damage scenario, little operational effects on biological resources will be created. Additional maintenance may be required following damage and would result in a minimal increase in operational effects over existing conditions.

Loss of Functionality: The damage sustained under the Loss of Functionality scenario would likely cause the release of pollutants from upland and marine sources into the nearshore and shifting debris would harm or kill organisms in the area. Input of contaminants would degrade habitat quality, primarily in the nearshore environment. Additional maintenance may be required following damage and would result in an additional increase in operational effects.

Collapse of the Seawall: As with the Loss of Functionality scenario, the Collapse of the Seawall scenario would create similar operational effects but would be much greater in scope and negatively impact biological resources in a substantially larger area. Additional negative operational effects would result from the subsequent emergency construction design to stabilize the area, which would be expected to further degrade environmental quality. Over the longer term, additional repairs and rebuilding would occur but would not likely remove the bulk of the material that had sluiced out into Elliott Bay.

6.2 ALTERNATIVE A

Operational effects from the proposed seawall replacement would largely be comparable to those of Alternatives B and C. Infrastructure elements such as the seawall, road and walking surfaces, and piles would remain in the proposed project area, perpetuating the highly altered environment relative to native conditions. Altered environmental conditions would be found in both upland and marine areas and continue to alter the native assemblage of species. Stormwater and CSO outfall locations would

remain essentially the same. Stormwater drainage pipes in the seawall construction area would be reconstructed, and stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and oils and greases. This would improve water quality in the nearshore of the study area. It would be expected that new stormwater structures would require less maintenance than those currently in place and, as a result, have fewer detrimental impacts on the environment. As the project design moves forward, other stormwater management strategies could be identified that provide greater environmental benefit without increasing environmental impacts. Any such strategies would be discussed fully in the Final EIS.

The primary habitat goal of Alternative A is to improve intertidal juvenile salmonid migration along the seawall and enhancing nearshore productivity important for supporting the ecosystem. This would be accomplished by modifying depths to achieve an intertidal habitat bench elevation (+0.5 to -4.5 NAVD 88), improving underwater substrates (three-inch and smaller aggregate), increasing daylight illumination of the habitat bench by including LPS in the pile-supported sidewalk above, increasing seawall texture to host aquatic organisms, and adding riparian plants along the wall and sidewalk. Additionally, select subtidal areas would be improved with the addition of kelp reefs (6-to-12-inch cobbles at 25-to-30-foot depth) and substrate enhancements (pea gravel and shell hash at 10-to-15-foot depth). Though constructed in an urban environment, these measures would replicate natural shoreline features and stimulate natural Puget Sound productivity.

Operational effects that would result from the construction of Alternative A would be primarily beneficial to the biological resources in the proposed project area. These operational effects are presented and discussed below.

6.2.1 Benefits of Habitat Enhancement

Habitat enhancements of Alternative A would generally result in converting what is now urbanized upland, deep water habitat, and riprap into nearshore habitat accessible to migrating salmonids and other wildlife and plants. The primary habitat enhancement goal of Alternative A is to improve intertidal juvenile salmonid migration along the seawall. This would be accomplished by modifying depths to achieve an intertidal habitat-bench elevation, improving underwater substrates, increasing daylight illumination of the habitat bench by incorporating LPS in the pile-supported sidewalk above, increasing seawall texture to host aquatic organisms, and adding riparian plants along the seawall and sidewalk. Additionally, select subtidal areas would be improved with the addition of kelp reefs and substrate enhancements. Though constructed in an urban environment, these measures replicate natural shoreline features and stimulate natural Puget Sound productivity.

Habitat enhancements for Alternative A would generally occur in three physical areas: the subtidal zone, intertidal zone, and upland zone (see Chapter 2, Figure 2-1). Unlike the enhancements proposed to occur in the upland zone, most of those proposed for the intertidal and subtidal zones would be in-water work. The proposed in-water work is designed to modify depths and place improved substrate. It would occur in the nearshore environment and have a high potential to impact the habitat and species that are present. Effects on the local ecosystem from the habitat enhancements proposed for Alternative A are anticipated to be substantial, with those that would ultimately result from

construction to be highly beneficial (those occurring during construction would likely be short term and moderately detrimental; see Chapter 5, Construction Effects and Mitigation for details).

A large portion of Alternative A is the habitat enhancements that would occur in the nearshore and upland areas. Examples include augmented habitat benches and reefs in the nearshore, riparian plantings in upland areas, textured walls on the seawall face, and placement of LPS and landscape-buffer strips in the upland areas. A summary of operational effects of these habitat enhancement features is presented below:

- **Augmented habitat benches and reefs in the nearshore**: Placement of aquatic habitat features would convert existing subtidal sand and riprap habitat and communities into a mix of intertidal and subtidal cobble/gravel habitat. In addition, it would increase the amount of shallow aquatic habitat in the area by approximately two acres as well as substantially improve its overall quality. Although the augmented habitat benches and reefs are intended to enhance habitat for salmonids, they would also improve habitat for all other native species that are part of the nearshore community.
- **Riparian plantings and landscape-buffer strips in upland areas**: Upland habitat features would primarily include riparian plantings which would be installed to provide overhanging vegetation for ecosystem productivity and support. The key outcome from these plantings is to provide riparian habitat for the terrestrial invertebrates salmonids rely on for food while in the nearshore. In addition, these plantings would also provide upland habitat currently absent from the area, that would aid in supporting various native birds and limited other wildlife species.
- **Textured walls on the seawall face**: The installation of new face panels would substantially increase substrate for intertidal algal and invertebrate attachment, increasing the quantity and quality of habitat found in and around the constructed seawall. The panels would likely be precast and installed behind the temporary containment wall. Once in place and colonized by invertebrates and alga, the overall habitat in the nearshore will be enhanced for additional species such as salmonids and other larger fish and wildlife.
- **Light-penetrating surfaces:** Under this alternative, the sidewalks would be replaced and cantilevered over the nearshore, and would generally be wider than what is existing (due to the seawall pullback) and partially constructed with LPS. Placing LPS in strategic locations to construct the walking surfaces would substantially enhance the amount of ambient light that penetrates into the nearshore environment. This would increase the total area of photozone, greatly improving the nearshore habitat quality beyond current conditions for photosynthetic organisms such as marine algae and some invertebrates. Its implementation; however, is primarily intended to reestablish a corridor of nearshore habitat with mostly unbroken ambient lighting, which would substantially improve the area for salmonid migration.

Although the installation and construction of these enhancements would undoubtedly result in some detrimental short-term effects on the existing environment, as discussed in Chapter 5, once completed, they should provide substantial long-term benefits to individual species and the ecosystem. Salmonids should benefit by gaining an improved migration corridor with higher quality refuge and rearing habitat. Juvenile rockfish should benefit from the expanded bull kelp beds and macroalgae expected to colonize the subtidal reefs. Substrates and bathymetry in the nearshore would be diversified, which would

provide improved habitat for various marine plants, invertebrates, and vertebrates. Upland areas would also benefit due to improved vegetation densities, distribution, and variety of native species. If the anticipated improvements do occur as the result of implementing Alternative A, it would be expected that various native species would increase in density and potentially in diversity along the approximately 6,328-foot length of nearshore in the proposed project area, and improve the overall natural environment in Elliott Bay.

6.2.2 Adverse Effects of Habitat Enhancement

While the benefits of the proposed habitat enhancements would be substantial for fish and other aquatic organisms, these enhancements would be constructed in an overall urbanized and degraded aquatic environment where contributing factors including CSO and stormwater outfalls, would largely continue functioning as they do under existing conditions. Point source locations would likely remain essentially the same (although depending on design, they could be consolidated) but stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and associated pollutants as well as oils and greases (City of Seattle Stormwater Code [SMC 22.800 - 22.808]) (further details are available in the Water Resources Discipline Report [SDOT 2012b]). This alternative could result in the enhanced habitat features drawing in increased densities of species, including listed salmonids, and exposing some of them to the continued, but reduced, inputs of pollutants. The City and King County are separately required to reduce their CSO outflows to no more than one discharge per year by 2025 and two of the four CSO outfalls along the waterfront may be reconfigured to no longer discharge to the study area. Thus, the overall pollutant loading will be decreased over time and the risk to fish and wildlife from these pollutants will be reduced. Potential remains for the habitat features to become contaminated by resuspension of the surrounding sediments or by discharges from outfalls, however unlikely. It should be noted that the intent of the design is to minimize the potential for these effects by separating outfall discharges from the immediate areas of habitat enhancements and by the elevation of the habitat bench compared to the surrounding existing sediments. It is anticipated that the improvements in habitat quality and quantity from this alternative, would minimize adverse effects and allow beneficial long-term effects to persist effectively over the long term.

Another contributing factor would be that the created nearshore habitat, and to a limited extent, the establishment of kelp on constructed reefs, could potentially alter water circulation in the nearshore of the proposed project area, particularly during low tidal periods. Although Alternative A, and likewise Alternative C, would be viewed to not have the same potential as Alternative B for altering water movements through the nearshore due to their reduced seawall setbacks, if water circulation is retarded in any way, pollutants from CSO and stormwater outfalls may not readily flush from the area, thus potentially increasing their rate of deposition. However, it is also possible that the net physical change of the nearshore may result in water circulation remaining comparable to current conditions or improving. It is currently unknown how Alternative A would affect water circulation in the nearshore. Until additional information becomes available on how circulation may change due to this alternative, it is expected that any minor adverse effects would be outweighed by the benefits from the Alternative A habitat enhancements. Overall, these adverse operational effects on the nearshore would be expected

to be at the most, long term and minor (it should be noted that these adverse effects could largely be eliminated with proper control of waterborne upland contaminants).

Attracting higher than existing densities of marine and upland species into the enhanced habitats of Alternative A, could potentially increase contact between these organisms and humans. Improvements made to marine habitat are likely to attract various species such as salmonids and other fish, invertebrates, birds, and potentially marine mammals. Similarly, improvements made to upland habitat may draw in native upland species such as various birds, coyote, raccoon, and opossum closer to the urban core of Seattle (e.g., see The Seattle Times 2009) through other partially restored neighboring parks (i.e., Discovery Park, Smith Cove Park, Myrtle Edwards Park, and Olympic Sculpture Park). Common conflicts between humans and fish or wildlife would likely include harassment to marine species, boat-strikes on marine species, window and car strikes of birds and upland mammals, depredation from domestic pets, attraction of wildlife to human wastes, and the feeding of wildlife by humans. Despite this potential, it is anticipated that even with some increased exposure of wildlife to humans, the habitat enhancements of Alternative A would provide a beneficial long-term effect on marine and upland habitats and associated communities and humans can be encouraged to appreciate living in closer proximity to wildlife. Overall, it is anticipated that these adverse operational effects on marine and upland species would be expected to be long term and minor.

Effects from maintenance activities on constructed habitat features are likely to be short term and minor, such as from small replacement of rock associated with the benches and cobble reefs, replacement of pea gravel/shell hash at the substrate enhancement locations, and from cleaning of LPS and wall areas.

6.2.3 Other Operational Effects

The reconstruction of Washington Street Boat Landing could result in minor continued long-term impacts on the nearshore environment. The replacement would continue the shading over a limited portion of the nearshore.

Maintenance of constructed non-habitat features (i.e., the seawall, public amenities, and roadway) would be required in the future and could potentially produce some additional adverse effects.

6.2.4 Operational Effects Summary

Overall, the effects from Alternative A are expected to be highly beneficial to the surrounding environment. Maintenance of the constructed features would need to occur in the future and would likely produce some temporary adverse effects, but the use of BMPs during maintenance activities would likely minimize effects. Only very minor, long-term, detrimental effects on marine and upland environments may occur under this alternative, primarily via disturbance from human and wildlife/fish contacts or conflicts. It is anticipated that the net operational effects from Alternative A would be **long term** and **highly beneficial** for the greater ecosystem.

6.3 ALTERNATIVE B

Operational effects from the proposed seawall replacement would be expected to be similar for Alternative B as those for Alternatives A and C; however, Alternative B would incur a larger net environmental benefit due to the larger seawall setback and increased area of habitat features.

Alternative B includes many of the same habitat enhancements as Alternative A and C but in expanded quantity and increased quality. The larger seawall setback and increased array of enhancements of Alternative B allows for this alternative to attain a larger area of habitat enhancements in the nearshore and upland areas. Additional enhancements of Alternative B are proposed in Zones 1, 3, and 4. Zone 1 includes a natural intertidal habitat bench surrounded by a subtidal kelp reef and bordered by upland riparian plants, rocks, and drift logs. The 30-foot wall setback in Zone 3 would allow for a wider habitat bench with LPS above. The 30- to 75-foot wall set back in Zone 4 would allow for either an expanded upland riparian planting or increased intertidal habitat.

Stormwater and CSO outfall point source locations would remain essentially the same. Stormwater drainage pipes in the seawall construction area would be reconstructed, and stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and oils and greases. This would improve water quality in the nearshore of the study area. It would be expected that new stormwater structures would require less maintenance than those currently in place and, as a result, have fewer detrimental impacts on the environment. As the project design moves forward, other stormwater management strategies could be identified that provide greater environmental benefit without increasing environmental impacts. Any such strategies would be discussed fully in the Final EIS.

Operational effects that would result from the construction of Alternative B would be primarily beneficial with only very minor adverse effects to the biological resources in the proposed project area. These operational effects are presented and discussed below.

6.3.1 Benefits of Habitat Enhancement

Habitat enhancements of Alternative B would generally result in converting what is now urbanized upland, deep water habitat, and riprap into nearshore habitat accessible to migrating salmonids and other wildlife and plants. The primary habitat enhancement goal of Alternative B is to improve intertidal juvenile salmonid migration along the seawall. This would be accomplished by modifying depths to achieve an intertidal habitat-bench elevation, improving underwater substrates, increasing daylight illumination of the habitat bench by incorporating LPS in the pile-supported sidewalk above, increasing seawall texture to host aquatic organisms, and adding riparian plants along the seawall and sidewalk. Additionally, select subtidal areas would be improved with the addition of kelp reefs and substrate enhancements. Though constructed in an urban environment, these measures would replicate natural shoreline features and stimulate natural Puget Sound productivity.

Habitat enhancements for Alternative B would generally occur in three physical areas: the subtidal zone, intertidal zone, and upland zone (see Chapter 2, Figure 2-1). Unlike the enhancements proposed to occur in the upland zone, most of those proposed for the intertidal and subtidal zones would be in-

water work. The proposed in-water work is designed to modify depths and place improved substrate. It would occur in the nearshore environment and have a high potential to impact the habitat and species that are present. Effects on the local ecosystem from the habitat enhancements proposed for Alternative B are anticipated to be substantial and highly beneficial (those occurring during construction would likely be short term and moderately detrimental; see Chapter 5, Construction Effects and Mitigation for details).

A large portion of Alternative B is the substantial habitat enhancements that would occur in the nearshore and upland areas. Alternative B provides habitat enhancement features that would be larger and of higher quality relative to those proposed for Alternative A or C. Examples include a larger seawall setback, widened habitat benches and backshore, and more extensive riparian plantings in upland areas. All build alternatives, however, share many other enhancements such as habitat benches and reefs in the nearshore, riparian plantings in upland areas, textured walls on the seawall face, and placement of LPS and landscape-buffer strips in the upland areas. A summary of operational effects of these habitat enhancement features is presented below:

- **Larger seawall setback (compared to Alternative A or C)**: The larger seawall setback of Alternative B facilitates the majority of the additional habitat enhancements beyond those offered by Alternative A or C. This key feature, in itself, is likely to have only minor direct operational effects but is essential for Alternative B to offer larger and higher quality habitat features than Alternative A or C.
- **Augmented habitat benches, beaches, and reefs in the nearshore**: Placement of aquatic habitat features would convert existing subtidal sand and riprap habitat and communities into a mix of intertidal and subtidal cobble/gravel habitat. In addition, it would increase the amount of shallow aquatic habitat in the area by approximately four acres (double that of Alternative A and approximately one-third more than Alternative C) as well as substantially improving its overall quality. Alternative B would also incorporate a large intertidal habitat bench with backshore surrounded by a subtidal kelp reef bordered by upland riparian plants, rocks, and drift logs that would provide additional marine and upland habitat. Although these collective features are intended to enhance habitat for salmonids, they would also substantially improve habitat for all other native species that are part of the nearshore and adjacent upland communities.
- **Textured walls on the seawall face**: The installation of new face panels would substantially increase substrate for intertidal algal and invertebrate attachment, increasing the quantity and quality of habitat found in and around the constructed seawall. The panels would likely be precast and installed behind the temporary containment wall. Once in place and colonized by invertebrates and alga, the overall habitat in the nearshore will be enhanced for additional species such as salmonids and other fish and wildlife.
- **Riparian plantings and landscape-buffer strips in upland areas**: Upland habitat features would primarily include riparian plantings, which would be installed to provide overhanging vegetation for ecosystem productivity and support. The key outcome from these plantings is to provide riparian habitat for the terrestrial invertebrates salmonids rely on for food while in the nearshore. In addition, these plantings would also provide upland habitat currently absent from the area that would aid in supporting various native birds and limited other

wildlife. Alternative B incorporates more of these features than Alternative A or C and would be expected to provide additional associated habitat.

- **Light-penetrating surfaces:** Placing LPS throughout the walking surfaces would substantially enhance the amount of ambient light that penetrates into the nearshore environment. This would increase the total area of the photic zone, greatly improving the nearshore habitat quality beyond current conditions for photosynthetic organisms such as marine algae and some invertebrates. Its implementation is intended to reestablish a corridor of nearshore habitat with unbroken ambient lighting, which would substantially improve the area for salmonid migration.

Although the installation and construction of these enhancements would undoubtedly result in some detrimental short-term effects on the existing environment, as discussed in Chapter 5, once completed, they should provide substantial long-term benefits to individual species and the ecosystem beyond current conditions and those offered by Alternatives A or C. Salmonids would benefit by gaining an improved migration corridor with higher quality refuge and rearing habitat. Juvenile rockfish would benefit from the expanded bull kelp beds and macroalgae expected to colonize the subtidal reefs. Substrates and bathymetry in the nearshore would be diversified, which would provide improved habitat for various marine plants, invertebrates, and vertebrates. Upland areas would also benefit due to improved vegetation densities, distribution, and variety of native species. If the anticipated improvements do occur as the result of implementing Alternative B, it would be expected that various native species would increase in density and potentially in diversity along the approximately 6,328-foot length of nearshore in the proposed project area, and improve the overall natural environment in Elliott Bay.

6.3.2 Adverse Effects of Habitat Enhancement

While the benefits of the proposed habitat enhancements would be substantial for fish and other aquatic organisms, these enhancements would be constructed in a degraded aquatic environment where contributing factors to the degradation including CSO and stormwater outfalls, would largely continue as they do under existing conditions. Point source locations would remain essentially the same but stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and associated pollutants as well as oils and greases (City of Seattle Stormwater Code [SMC 22.800–22.808]) (further details are available in the Water Resources Discipline Report [SDOT 2012b]). This alternative could result in the enhanced habitat features drawing in increased densities of species, including listed salmonids, and exposing some of them to the continued, but reduced, inputs of pollutants. The City and King County are separately required to reduce their CSO outflows to no more than one discharge per year by 2025 and two of the four CSO outfalls along the waterfront may be reconfigured to no longer discharge to the study area. Thus, the overall pollutant loading will be decreased over time and the risk to fish and wildlife from these pollutants will be reduced. Potential remains for the habitat features to become contaminated by resuspension of the surrounding sediments or by discharges from outfalls, however unlikely. It should be noted that the intent of the design is to minimize the potential for these effects by separating outfall discharges from the immediate areas of habitat enhancements and by the elevation of the habitat

bench compared to the surrounding existing sediments. It is anticipated that the improvements in habitat quality and quantity from this alternative, would minimize adverse effects and allow beneficial long-term effects to persist effectively over the long term.

Another contributing factor would be that the created nearshore habitat, and to a limited extent, the establishment of kelp on constructed reefs, may alter water circulation in the nearshore of the proposed project area, particularly during low tidal periods. Alternative B is viewed to have more potential than Alternative A or C for altering water movements due to its greater seawall setback. If water circulation is retarded in any way, pollutants from CSO and stormwater outfalls may not readily flush from the area, thus potentially increasing their rate of deposition. However, it is also possible that the net physical change of the nearshore may result in water circulation remaining comparable to current conditions or improving. It is currently unknown how the proposed construction of Alternative B would affect water circulation in the nearshore. Overall, these adverse operational effects on the nearshore would be expected to be at the most, long term and minor (it should be noted that these adverse effects could largely be eliminated with proper control of waterborne upland contaminants).

Attracting higher than existing densities of marine and upland species into the enhanced habitats constructed under Alternative B, could potentially increase contact between these organisms and humans. Improvements made to marine habitat are likely to attract various species such as salmonids and other fish, invertebrates, birds, and potentially marine mammals. Similarly, improvements made to upland habitat may draw in native upland species such as various birds, coyote, raccoon, and opossum closer to the urban core of Seattle (e.g., see The Seattle Times 2009) through other partially restored neighboring parks (i.e., Discovery Park, Smith Cove Park, Myrtle Edwards Park, and Olympic Sculpture Park). Common conflicts between humans and fish or wildlife would likely include harassment to marine species from fishing or other sea harvests, boat-strikes on marine species, window and car strikes of birds and upland mammals, depredation from domestic pets, attraction of wildlife to human wastes, and the feeding of wildlife by humans. Despite this potential, it is anticipated that even with some increased exposure of wildlife to humans, the habitat enhancements of Alternative B would provide a beneficial long-term effect on marine and upland habitats and associated communities, and humans can be encouraged to appreciate living in closer proximity to wildlife. Overall, these adverse operational effects on marine and upland species would be expected to be long term and minor.

Effects from maintenance activities on constructed habitat features are likely to be short term and minor, such as from small replacement of rock associated with the benches and cobble reefs, replacement of pea gravel/shell hash at the substrate enhancement locations, and from cleaning of LPS and wall areas.

6.3.1 Other Operational Effects

The reconstruction of Washington Street Boat Landing and potential installation of a gangway and short-term boat moorage could result in minor to moderate long-term impacts on the nearshore environment. The installation of a gangway and overwater moorage structures, would cause a minor increase of shading over a portion of the nearshore. If additional shading does result, the disruption of movements and alteration of distributions of various species, including listed salmonids, could occur.

Sessile species such as invertebrates and plants would also likely be reduced in this area due to the reduction in natural light penetration. It would be expected, however, that any additional shading of the nearshore as the result of this action would not be substantial. Using LPS wherever feasible would help reduce negative impacts.

The potential installation of the short-term boat moorage would likely increase boat-traffic in the area. It would be expected that increased boat traffic would lead to increases in disturbance to the immediate nearshore and upland habitats as well as the potential for boating-related wastes such as fuels, lubricants, and refuse to enter the natural environment. Over time, these impacts could degrade the quality of the habitat in the immediate area. However, implementing or enforcing regulations on boaters that would not allow the discharge of wastes would reduce their impact on the natural environment would largely reduce any negative impacts associated with this feature.

Maintenance of constructed non-habitat features (i.e., the seawall, public amenities, and roadway) would be required in the future and would likely produce some additional adverse effects via disturbance, but the use of BMPs during maintenance activities would minimize any potential effects.

6.3.2 Operational Effects Summary

Overall, the effects from the proposed habitat enhancements presented for Alternative B are expected to be highly beneficial to the surrounding environment and beyond those offered by Alternative A or C. Maintenance of the constructed features would need to occur in the future and would likely produce some additional adverse effects. Although some long-term detrimental effects on marine and upland environments may occur as a result of disturbance or contact/conflict with humans, it is anticipated that the net operational effects from Alternative B would be **long term** and **highly beneficial** for the greater ecosystem and greater than those provided by Alternative A or C.

6.4 ALTERNATIVE C

Operational effects from the proposed seawall replacement would largely be comparable to those of Alternatives A and B. Infrastructure elements such as the seawall, road and walking surfaces, and piles would remain in the proposed project area, perpetuating the highly altered environment relative to natural conditions. Altered environmental conditions would be found in both upland and marine areas and continue to alter the native assemblage of species. Stormwater and CSO outfall point source locations would remain essentially the same. Stormwater drainage pipes in the seawall construction area would be reconstructed, and stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and oils and greases. This would improve water quality in the nearshore of the study area. It would be expected that new stormwater structures would require less maintenance than those currently in place and, as a result, have fewer detrimental impacts on the environment. As the project design moves forward, other stormwater management strategies could be identified that provide greater environmental benefit without increasing environmental impacts. Any such strategies would be discussed fully in the Final EIS.

The primary habitat goal of Alternative C is to improve intertidal juvenile salmonid migration along the seawall and enhance nearshore productivity important for supporting the ecosystem. This would be

accomplished by modifying depths to achieve an intertidal habitat bench elevation (+0.5 to -4.5 NAVD 88), improving underwater substrates (three-inch and smaller aggregate), increasing daylight illumination of the habitat bench by including LPS in the pile-supported sidewalk above, increasing seawall texture to host aquatic organisms, and adding riparian plants along the wall and sidewalk. Additionally, select subtidal areas would be improved with the addition of substrate enhancements (pea gravel and shell hash at 10-to-15-foot depth). Though constructed in an urban environment, these measures would replicate natural shoreline functions and stimulate natural Puget Sound productivity.

Operational effects that would result from the construction of Alternative C would be primarily beneficial to the biological resources in the proposed project area. These operational effects are presented and discussed below.

6.4.1 Benefits of Habitat Enhancement

Habitat enhancements of Alternative C would generally result in converting what is now urbanized upland, relatively deep-water habitat, and riprap into nearshore habitat accessible to migrating salmonids and other wildlife and plants. The primary habitat enhancement goal of Alternative C is to improve intertidal juvenile salmonid migration along the seawall. This would be accomplished by modifying depths to achieve an intertidal habitat-bench elevation, improving underwater substrates, increasing daylight illumination of the habitat bench by incorporating LPS in the pile-supported sidewalk above, increasing seawall texture to host aquatic organisms, and adding riparian plants along the sidewalk. Additionally, select subtidal areas would be improved with the addition of substrate enhancements. Though constructed in an urban environment, these measures replicate natural shoreline functions and stimulate natural Puget Sound productivity.

Habitat enhancements for Alternative C would generally occur in three physical areas: the subtidal zone, intertidal zone, and upland zone (see Chapter 2, Figure 2-1). Unlike the enhancements proposed to occur in the upland zone, most of those proposed for the intertidal and subtidal zones would be in-water work. The proposed in-water work is designed to modify depths and place improved substrate. It would occur in the nearshore environment and have a high potential to impact the habitat and species that are present. Effects on the local ecosystem from the habitat enhancements proposed for Alternative C are anticipated to be substantial, with those that would ultimately result from construction to be highly beneficial (those occurring during construction would likely be short term and moderately detrimental; see Chapter 5, Construction Effects and Mitigation for details).

A large portion of Build Alternative C is the habitat enhancements that would occur in the nearshore and upland areas. Examples include augmented habitat benches in the nearshore, riparian plantings in upland areas, textured walls on the seawall face, and placement of LPS and landscape-buffer strips in the upland areas. A summary of operational effects of these habitat enhancement features is presented below:

- **Augmented habitat benches in the nearshore**: Placement of aquatic habitat features would convert existing subtidal sand and riprap habitat and communities into a mix of intertidal and subtidal cobble/gravel habitat. In addition, it would increase the amount of shallow aquatic habitat in the area by approximately two acres as well as substantially improve its overall quality. Although the augmented habitat benches are intended to enhance habitat for salmonids, they would also improve habitat for all other native species that are part of the nearshore community.
- **Riparian plantings and landscape-buffer strips in upland areas**: Upland habitat features would primarily include riparian plantings, which would be installed to provide overhanging vegetation for ecosystem productivity and support. The key outcome from these plantings is to provide riparian habitat for the terrestrial invertebrates salmonids rely on for food while in the nearshore. In addition, these plantings would also provide upland habitat currently absent from the area, that would aid in supporting various native birds and limited other wildlife species.
- **Textured walls on the seawall face**: The installation of new face panels would substantially increase substrate for intertidal algal and invertebrate attachment, increasing the quantity and quality of habitat found in and around the constructed seawall. The panels would likely be precast and installed behind the temporary containment wall. Once in place and colonized by invertebrates and alga, the overall habitat in the nearshore will be enhanced for additional species such as salmonids and other fish and wildlife.
- **Light-penetrating surfaces:** Under this alternative, the sidewalks would be replaced and cantilevered over the nearshore, and would generally be wider than what is existing (due to the seawall pullback) and constructed with LPS. Placing LPS throughout the walking surfaces would substantially enhance the amount of ambient light that penetrates into the nearshore environment. This would increase the total area of the photic zone, greatly improving the nearshore habitat quality beyond current conditions for photosynthetic organisms such as marine algae and some invertebrates. Its implementation; however, is primarily intended to reestablish a corridor of nearshore habitat with unbroken ambient lighting, which would substantially improve the area for salmonid migration.

Although the installation and construction of these enhancements would result in some detrimental short-term effects on the existing environment, as discussed in Chapter 5, once completed, they should provide substantial long-term benefits to individual species and the ecosystem. Salmonids should benefit by gaining an improved migration corridor with higher quality refuge and rearing habitat. Juvenile rockfish should benefit from the expanded bull kelp beds and macroalgae expected to colonize the subtidal substrate and outer slopes of the habitat benches. Substrates and bathymetry in the nearshore would be diversified, which would provide improved habitat for various marine plants, invertebrates, and vertebrates. Upland areas would also benefit due to improved vegetation densities, distribution, and variety of native species. If the anticipated improvements do occur as the result of implementing Alternative C, it would be expected that various native species would increase in density and potentially in diversity along the approximately 7,000-foot length of nearshore in the proposed project area, and improve the overall natural environment in Elliott Bay.

6.4.2 Adverse Effects of Habitat Enhancement

While the benefits of the proposed habitat enhancements would be substantial for fish and other aquatic organisms, these enhancements would be constructed in an overall urbanized and degraded aquatic environment where contributing factors to the degradation including CSO and stormwater outfalls, would largely continue as they do under existing conditions. Point source locations would remain essentially the same but stormwater quality would be improved through the installation of stormwater treatment to meet code which would remove the bulk of suspended solids and associated pollutants as well as oils and greases (City of Seattle Stormwater Code [SMC 22.800–22.808]) (further details are available in the Water Resources Discipline Report [SDOT 2012b]). This alternative could result in the enhanced habitat features drawing in increased densities of species, including listed salmonids, and exposing some of them to the continued, but reduced, inputs of pollutants. The City and King County are separately required to reduce their CSO outflows to no more than one discharge per outfall per year by 2025 and two of the four CSO outfalls along the waterfront may be reconfigured to no longer discharge to the study area. Thus, the overall pollutant loading will be substantially decreased over time and the risk to fish and wildlife from these pollutants will be reduced. Potential remains for the habitat features to become contaminated by resuspension of the surrounding sediments or by discharges from outfalls, however unlikely. It should be noted that the intent of the design is to minimize the potential for these effects by separating outfall discharges from the immediate areas of habitat enhancements and by the elevation of the habitat bench well above the surrounding existing sediments. It is anticipated that the improvements in habitat quality and quantity from this alternative, would minimize adverse effects and allow beneficial long-term effects to persist effectively over the long term.

Another contributing factor would be that the created nearshore habitat, and to a limited extent, the establishment of kelp on the habitat bench slopes, could potentially alter water circulation in the nearshore of the proposed project area, particularly during low tidal periods. Although Alternative C, and likewise Alternative A, would be viewed to not have the same potential as Alternative B for altering water movements through the nearshore due to their reduced seawall setbacks, if water circulation is affected in any way, pollutants from CSO and stormwater outfalls may not readily flush from the area, thus potentially increasing their rate of deposition. However, it is also possible that the net physical change of the nearshore may result in water circulation remaining comparable to current conditions or even be improved. It is currently unknown how Alternative C would affect water circulation in the nearshore. Until additional information becomes available on how circulation may change due to this alternative, it is expected that any minor adverse effects would be largely balanced by the benefits from the Alternative C habitat enhancements. Overall, these adverse operational effects on the nearshore would be expected to be at the most, long term and minor (it should be noted that these adverse effects could largely be eliminated with proper control of waterborne upland contaminants).

Attracting higher than existing densities of marine and upland species into the enhanced habitats of Alternative C, could potentially increase contact between these organisms and humans. Improvements made to marine habitat are likely to attract various species such as salmonids and other fish, invertebrates, birds, and potentially marine mammals. Similarly, improvements made to upland habitat

may draw in native upland species such as various birds, coyote, raccoon, and opossum closer to the urban core of Seattle (e.g., see The Seattle Times 2009) through other partially restored neighboring parks (i.e., Discovery Park, Smith Cove Park, Myrtle Edwards Park, and Olympic Sculpture Park). Common conflicts between humans and fish or wildlife would likely include harassment to marine species, boat-strikes on marine species, window and car strikes of birds and upland mammals, depredation from domestic pets, attraction of wildlife to human wastes, and the feeding of wildlife by humans. Despite this potential, it is anticipated that even with some increased exposure of wildlife to humans, the habitat enhancements of Alternative C would provide a beneficial long-term effect on marine and upland habitats and associated communities and humans can be encouraged to appreciate living in closer proximity to wildlife. Overall, it is anticipated that these adverse operational effects on marine and upland species would be expected to be long term and minor.

Effects from maintenance activities on constructed habitat features are likely to be short term and minor, such as from small replacement of rock associated with the benches, replacement of pea gravel/shell hash at the substrate enhancement locations, and from cleaning of LPS and wall areas.

6.4.3 Other Operational Effects

The reconstruction of Washington Street Boat Landing could result in minor long-term impacts on the nearshore environment; primarily associated with the continuation of overwater coverage.

Maintenance of constructed non-habitat features (i.e., the seawall, public amenities, and roadway) would be required in the future and would likely produce some additional adverse effects via disturbance, but the use of BMPs during maintenance activities would minimize any potential effects.

6.4.4 Operational Effects Summary

Overall, the effects from the proposed habitat enhancements presented for Alternative C are expected to be highly beneficial to the surrounding environment and beyond those offered by Alternative A but less than those from Alternative B. Maintenance of the constructed features would need to occur in the future and would likely produce some additional adverse effects. Although some long-term detrimental effects on marine and upland environments may occur as a result of disturbance or contact/conflict with humans, it is anticipated that the net operational effects from Alternative C would be **long term** and **highly beneficial** for the greater ecosystem and greater than that provided by Alternative A but less than Alternative B.

6.5 INDIRECT EFFECTS

The primary direct effects of this project on fish, wildlife, and vegetation across all build alternatives would be to increase habitats for native species and to increase populations and/or densities in the proposed project area. A secondary or indirect effect of increased fish, wildlife, and/or vegetation populations could be that these increases would extend beyond the proposed project area, enhancing the biological resources in the immediate region. Any increase in native fish, wildlife, and/or vegetation populations could also enhance fishing and wildlife-observation opportunities.

6.6 MITIGATION MEASURES

Construction of Alternatives A, B or C would have many of the same operational effects on biological resources. While many of the operational effects would be beneficial, others could be detrimental and require BMPs and mitigation measures to optimize the benefits to the local ecosystem. Potential BMPs and mitigation measures for reducing detrimental impacts include:

- Maintenance activities (on both habitat and non-habitat features) should use applicable BMPs and mitigation measures described in Section 5.6. Examples likely would include the use of silt curtains, noise and vibration attenuating techniques and technology, proper management of maintenance materials, limiting in-water maintenance to appropriate work windows, etc.
- Shading of the nearshore from the construction of overwater walkways would be largely mitigated by the use of LPS, to the maximum extent possible.
- Proper boat moorage design (Alternative B) limiting the number of moored boats and/or implementing or enforcing regulations on boaters that would reduce their impact on the natural environment.
- Methods to minimize night-time street lighting effects on the aquatic environment, such as the use of red/yellow spectrum light, lamp shields, and the direction of lighting would be employed as feasible.
- Conduct monitoring of habitat features and salmonid migration for several years following construction. Data from monitoring will allow the various habitat features to be assessed over the long-term for effectiveness, durability, maintenance needs, and general ability to enhance the local environment. As monitoring data accrue, operational manipulations could occur to optimize the environmental enhancements of the proposed project.

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CHAPTER 7. REFERENCES

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City of Seattle

Fish, Wildlife, and Vegetation Discipline Report

APPENDIX A.
SPECIES LISTS

October 2012

Table A-1. Fish Species Found in the Nearshore of the Study Area A-1
Table A-2. ESA-Listed West Coast Salmon and Steelhead that May Occur in the Project Area A-2
Table A-3. Other ESA-Listed Fish Species that May Occur in the Project Area A-3
Table A-4. ESA-Listed Marine Mammals that May Occur in the Project Area A-3
Table A-5. ESA-Listed Marine Turtles that May Occur In The Project Area A-3
Table A-6. ESA-Listed Species under the Jurisdiction of USFWS that are Listed for King County, Washington A-4
Table A-7. WDFW List of Sensitive Species A-6
Table A-8. A Complete List of Species under the Pacific Coast Groundfish EFH (90 Species)....A-10
Table A-9. A Complete List of Species under the West Coast Salmon EFH (76 Species)....A-13

TABLE A-1. FISH SPECIES FOUND IN THE NEARSHORE OF THE STUDY AREA

Common Name	Scientific Name
Black Rockfish	*Sebastes melanops*
Brown Rockfish	*Sebastes auriculatus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Chum Salmon	*Oncorhynchus keta*
Coho Salmon	*Oncorhynchus kisutch*
Crescent Gunnel	*Pholis laeta*
Kelp Perch	*Brachyistius frenatus*
Lamprey	*Lampetra tridentata*
Lingcod	*Ophiodon elongatus*
Longfin Gunnel	*Pholis clemensi*
Northern Clingfish	*Gobiesox maeandrichs*
Pacific Herring	*Clupea harengus*
Pacific Sand Lance	*Ammodytes hexapterus*
Painted Greenling	*Oxyleius pictus*
Pile Perch	*Rhacochilus vacca*
Quillback Rockfish	*Sebastes maliger*
Ratfish	*Hydrolagus colliei*
Red Irish Lord	*Hemilepidotus hemilepidotus*
Rockweed Gunnel	*Xererpes fucorum*
Sailfin Sculpin	*Nautichthys oculofasciatus*
Shiner Perch	*Cymatogaster aggregata*
Snake Prickleback	*Lumpenus sagitta*
Speckled Sanddab	*Citharichthys stigmaeus*
Spotted Ratfish	*Hydrolagus colliei*
Steelhead Trout	*Oncorhynchus mykiss*
Striped Perch	*Embiotoca lateralis*
Threespine Stickleback	*Gasterosteus aculeatus*
Tubesnout	*Aulorhynchus flavidus*
Wolf Eel	*Anarrhichthys ocellatus*

Sources: Matsuda et al. 1968; DeLacey et al. 1972; Weitkamp and Ruggerone 2000; Anchor Environmental 2002; WSDOT 2006; Toft et al. 2010; City of Seattle 2011a; Anchor QEA 2012).

TABLE A-2. ESA-LISTED WEST COAST SALMON AND STEELHEAD THAT MAY OCCUR IN THE PROJECT AREA (UPDATED JULY 1, 2009)

Species[1]			*Current Endangered Species Act Listing Status*[2]	*ESA Listing Actions Under Review*
Sockeye Salmon (*Oncorhynchus nerka*)	1	Snake River	*Endangered*	
	2	Ozette Lake	*Threatened*	
	3	Baker River	*Not Warranted*	
	4	Okanogan River	*Not Warranted*	
	5	Lake Wenatchee	*Not Warranted*	
	6	Quinalt Lake	*Not Warranted*	
	7	Lake Pleasant	*Not Warranted*	
Chinook Salmon (*O. tshawytscha*)	8	Sacramento River Winter-run	*Endangered*	
	9	Upper Columbia River Spring-run	*Endangered*	
	10	Snake River Spring/Summer-run	*Threatened*	
	11	Snake River Fall-run	*Threatened*	
	12	Puget Sound	*Threatened*	
	13	Lower Columbia River	*Threatened*	
	14	Upper Willamette River	*Threatened*	
	15	Central Valley Spring-run	*Threatened*	
	16	California Coastal	*Threatened*	
	17	Central Valley Fall and Late Fall-run	*Species of Concern*	
	18	Upper Klamath-Trinity Rivers	*Not Warranted*	
	19	Oregon Coast	*Not Warranted*	
	20	Washington Coast	*Not Warranted*	
	21	Middle Columbia River spring-run	*Not Warranted*	
	22	Upper Columbia River summer/fall-run	*Not Warranted*	
	23	Southern Oregon and Northern California Coast	*Not Warranted*	
	24	Deschutes River summer/fall-run	*Not Warranted*	
Coho Salmon (*O. kisutch*)	25	Central California Coast	*Endangered*	
	26	Southern Oregon/Northern California	*Threatened*	
	27	Lower Columbia River	*Threatened*	• Critical habitat
	28	Oregon Coast	*Threatened*	
	29	Southwest Washington	*Undetermined*	
	30	Puget Sound/Strait of Georgia	*Species of Concern*	
	31	Olympic Peninsula	*Not Warranted*	
Chum Salmon (*O. keta*)	32	Hood Canal Summer-run	*Threatened*	
	33	Columbia River	*Threatened*	
	34	Puget Sound/Strait of Georgia	*Not Warranted*	
	35	Pacific Coast	*Not Warranted*	
Steelhead (*O. mykiss*)	36	Southern California	*Endangered*	
	37	Upper Columbia River	*Threatened*	
	38	Central California Coast	*Threatened*	
	39	South Central California Coast	*Threatened*	
	40	Snake River Basin	*Threatened*	
	41	Lower Columbia River	*Threatened*	
	42	California Central Valley	*Threatened*	
	43	Upper Willamette River	*Threatened*	
	44	Middle Columbia River	*Threatened*	
	45	Northern California	*Threatened*	
	46	Oregon Coast	*Species of Concern*	
	47	Southwest Washington	*Not Warranted*	
	48	Olympic Peninsula	*Not Warranted*	
	49	Puget Sound	*Threatened*	• Critical habitat
	50	Klamath Mountains Province	*Not Warranted*	
Pink Salmon (*O. gorbuscha*)	51	Even-year	*Not Warranted*	
	52	Odd-year	*Not Warranted*	

1 The ESA defines a "species" to include any distinct population segment of any species of vertebrate fish or wildlife. For Pacific salmon, NOAA Fisheries Service considers an evolutionarily significant unit, or "ESU," a "species" under the ESA. For Pacific steelhead, NOAA Fisheries Service has delineated distinct population segments (DPSs) for consideration as "species" under the ESA.

TABLE A-3. OTHER ESA-LISTED FISH SPECIES THAT MAY OCCUR IN THE PROJECT AREA (UPDATED JUNE 15, 2010)

Species	Current ESA Listing Status	ESA Listing Actions Under Review
Bocaccio *(Sebastes paucispinis)*	Endangered	--
Canary rockfish *(Sebastes pinniger)*	Threatened	--
Yelloweye rockfish *(Sebastes ruberrimus)*	Threatened	--

TABLE A-4. ESA-LISTED MARINE MAMMALS THAT MAY OCCUR IN THE PROJECT AREA (UPDATED JUNE 15, 2010)

Species	Current ESA Listing Status	ESA Listing Actions Under Review
Southern Resident killer whale (*Orcinus orca*)	Endangered	Critical Habitat
Humpback whale (*Megaptera novaeangliae*)	Endangered	--
Steller sea lion (*Eumetopias jubatus*)	Threatened	Critical Habitat

TABLE A-5. ESA-LISTED MARINE TURTLES THAT MAY OCCUR IN THE PROJECT AREA (UPDATED OCTOBER 25, 2010)

Species	Current ESA Listing Status	ESA Listing Actions Under Review
Leatherback sea turtle *(Dermochelys coriacea)*	Endangered	--
Green sea turtle (*Chelonia mydas)*	Endangered	--
Olive Ridley sea turtle (*Lepidochelys olivacea)*	Endangered	--
Loggerhead sea turtle *(Caretta caretta)*	Threatened	--

TABLE A-6. ESA-LISTED SPECIES UNDER THE JURISDICTION OF USFWS THAT ARE LISTED FOR KING COUNTY, WASHINGTON

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CRITICAL HABITAT; CANDIDATE SPECIES; AND SPECIES OF CONCERN
IN KING COUNTY
AS PREPARED BY
THE U.S. FISH AND WILDLIFE SERVICE
WASHINGTON FISH AND WILDLIFE OFFICE

(Revised December 15, 2010)

LISTED

Bull trout *(Salvelinus confluentus)* – Coastal-Puget Sound DPS
Canada lynx *(Lynx canadensis)*
Gray wolf *(Canis lupus)*
Grizzly bear *(Ursus arctos = U. a. horribilis)*
Marbled murrelet *(Brachyramphus marmoratus)*
Northern spotted owl *(Strix occidentalis caurina)*

Major concerns that should be addressed in your Biological Assessment of project impacts to listed animal species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project activities and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to listed species and/or their avoidance of the project area.

Castilleja levisecta (golden paintbrush) [historic]

Major concerns that should be addressed in your Biological Assessment of project impacts to listed plant species include:

1. Distribution of taxon in project vicinity.

2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.

1. Changes in hydrology where taxon is found.

DESIGNATED

Critical habitat for bull trout
Critical habitat for the marbled murrelet
Critical habitat for the northern spotted owl

PROPOSED

Revised critical habitat for bull trout

CANDIDATE

Fisher *(Martes pennanti)* – West Coast DPS
North American wolverine *(Gulo gulo luteus)* – contiguous U.S. DPS
Oregon spotted frog *(Rana pretiosa)* [historic]
Yellow-billed cuckoo *(Coccyzus americanus)*

SPECIES OF CONCERN

Bald eagle *(Haliaeetus leucocephalus)*
Beller's ground beetle *(Agonum belleri)*
Cascades frog *(Rana cascadae)*
Hatch's click beetle *(Eanus hatchi)*
Larch Mountain salamander *(Plethodon larselli)*
Long-eared myotis *(Myotis evotis)*
Long-legged myotis *(Myotis volans)*
Northern goshawk *(Accipiter gentilis)*
Northern sea otter *(Enhydra lutris kenyoni)*
Northwestern pond turtle *(Emys (= Clemmys) marmorata marmorata)*
Olive-sided flycatcher *(Contopus cooperi)*
Pacific lamprey *(Lampetra tridentata)*
Pacific Townsend's big-eared bat *(Corynorhinus townsendii townsendii)*
Peregrine falcon *(Falco peregrinus)*
River lamprey *(Lampetra ayresi)*
Tailed frog *(Ascaphus truei)*
Valley silverspot *(Speyeria zerene bremeri)*
Western toad *(Bufo boreas)*
Aster curtus (white-top aster)
Botrychium pedunculosum (stalked moonwort)
Cimicifuga elata (tall bugbane)

TABLE A-7. WDFW LIST OF SENSITIVE SPECIES

Common Name	Scientific Name	Animal Type	State	Federal	Mapping Criteria
American white pelican	*Pelecanus erythrorhynchos*	Bird	SE	none	B,RSC
Bald eagle	*Haliaeetus leucocephalus*	Bird	SS	FCo	B,RSC,CR
Beller's ground beetle	*Agonum belleri*	Other Insect	SC	FCo	IO
Black right whale	*Balaena glacialis*	Mammal	SE	FE	IO
Black rockfish	*Sebastes melanops*	Fish	SC	none	IO
Black-backed woodpecker	*Picoides arcticus*	Bird	SC	none	B,RI
Black-tailed jackrabbit	*Lepus californicus*	Mammal	SC	none	IO
Blue whale	*Baleonoptera musculus*	Mammal	SE	FE	IO
Bluegray Taildropper	*Prophysaon coeruleum*	Mollusk	SC	none	IO
Bocaccio rockfish	*Sebastes paucispinis*	Fish	SC	FE	IO
Bog idol leaf beetle	*Donacia idola*	Other Insect	SC	none	IO
Brandt's cormorant	*Phalacrocorax penicillatus*	Bird	SC	none	B
Brown pelican	*Pelecanus occidentalis*	Bird	SE	FCo	RSC
Brown rockfish	*Sebastes auriculatus*	Fish	SC	FCo	IO
Bull trout	*Salvelinus confluentus*	Fish	SC	FT	none
Burrowing owl	*Athene cunicularia*	Bird	SC	FCo	B
California floater	*Anodonta californiensis*	Mollusk	SC	FCo	IO
California mountain kingsnake	*Lampropeltis zonata*	Reptile	SC	none	IO
Canary rockfish	*Sebastes pinniger*	Fish	SC	FT	IO
Cascade red fox	*Vulpes vulpes cascadensis*	Mammal	SC	none	IO
Cascade torrent salamander	*Rhyacotriton cascadae*	Amphibian	SC	none	IO
Cassin's auklet	*Ptychoramphus aleuticus*	Bird	SC	FCo	B
China rockfish	*Sebastes nebulosus*	Fish	SC	none	none
Chinook salmon (Lower Columbia)	*Oncorhynchus tshawytscha*	Fish	SC	FT	none
Chinook salmon (Puget Sound)	*Oncorhynchus tshawytscha*	Fish	SC	FT	none
Chinook salmon (Snake R. Fall)	*Oncorhynchus tshawytscha*	Fish	SC	FT	none
Chinook salmon (Snake R. Sp/Su)	*Oncorhynchus tshawytscha*	Fish	SC	FT	none
Chinook salmon (Upper Columbia Sp)	*Oncorhynchus tshawytscha*	Fish	SC	FE	none
Chinquapin hairstreak	*Habrodais grunus herri*	Butterfly/Moth	SC	none	IO
Chum salmon (Hood Canal Su)	*Oncorhynchus keta*	Fish	SC	FT	none
Chum salmon (Lower Columbia)	*Oncorhynchus keta*	Fish	SC	FT	none
Clark's grebe	*Aechmophorus clarkii*	Bird	SC	none	B
Coho salmon (Lower Columbia/SW WA)	*Oncorhynchus kisutch*	Fish	none	FT	none
Columbia clubtail (dragonfly)	*Gomphus lynnae*	Other Insect	SC	FCo	IO
Columbia oregonian	*Cryptomastix hendersoni*	Mollusk	SC	none	IO
Columbia pebblesnail	*Fluminicola columbiana*	Mollusk	SC	FCo	IO
Columbia River tiger beetle	*Cicindela columbica*	Other Insect	SC	none	IO
Columbia spotted frog	*Rana luteiventris*	Amphibian	SC	none	IO
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus*	Bird	ST	FCo	B,RSC
Columbian white-tailed deer	*Odocoileus virginianus*	Mammal	SE	FE	IO

Common Name	Scientific Name	Animal Type	State	Federal	Mapping Criteria
	leucurus				
Common loon	*Gavia immer*	Bird	SS	none	B
Common murre	*Uria aalge*	Bird	SC	none	B,RC
Copper rockfish	*Sebastes caurinus*	Fish	SC	FCo	IO
Dalle's Sideband	*Monadenia fidelis minor*	Mollusk	SC	none	
Dunn's salamander	*Plethodon dunni*	Amphibian	SC	none	IO
Eulachon	*Thaleichthys pacificus*	Fish	SC	FT	RC
Ferruginous hawk	*Buteo regalis*	Bird	ST	FCo	B
Fin whale	*Baleonoptera physalus*	Mammal	SE	FE	IO
Fisher	*Martes pennanti*	Mammal	SE	FC	IO
Flammulated owl	*Otus flammeolus*	Bird	SC	none	B,RI
Giant Columbia River limpet	*Fisherola nuttalli*	Mollusk	SC	none	IO
Giant Palouse earthworm	*Driloleirus americanus*	Annelid	SC	none	IO
Golden eagle	*Aquila chrysaetos*	Bird	SC	none	B
Gray whale	*Eschrichtius robustus*	Mammal	SS	none	IO
Gray wolf	*Canis lupus*	Mammal	SE	FE	IO
Gray-tailed vole	*Microtus canicaudus*	Mammal	SC	none	IO
Great arctic	*Oeneis nevadensis gigas*	Butterfly/Moth	SC	FCo	IO
Greater Sage-grouse	*Centrocercus urophasianus*	Bird	ST	FC	B,RSC
Green sea turtle	*Chelonia mydas*	Reptile	ST	FT	IO
Green sturgeon	*Acipenser medirostris*	Fish	none	FT	IO
Greenstriped rockfish	*Sebastes elongatus*	Fish	SC	none	IO
Grizzly bear	*Ursus arctos*	Mammal	SE	FT	IO
Hatch's click beetle	*Eanus hatchi*	Other Insect	SC	FCo	IO
Humpback whale	*Megaptera novaeangliae*	Mammal	SE	FE	IO
Island Marble	*Euchloe ausonides*	Butterfly/Moth	SC	FCo	IO
Johnson's hairstreak	*Mitoura johnsoni*	Butterfly/Moth	SC	none	IO
Juniper hairstreak	*Mitoura grynea barryi*	Butterfly/Moth	SC	none	IO
Keen's myotis	*Myotis keenii*	Mammal	SC	none	B,IO
Killer whale	*Orcinus orca*	Mammal	SE	FE	IO
Kokanee (Lk Sammamish)	*Oncorhynchus nerka*	Fish	none	FC	none
Lake chub	*Couesius plumbeus*	Fish	SC	none	IO
Larch Mountain salamander	*Plethodon larselli*	Amphibian	SS	FCo	IO
Leatherback sea turtle	*Dermochelys coriacea*	Reptile	SE	FE	IO
Leopard dace	*Rhinichthys falcatus*	Fish	SC	none	IO
Leschi's Millipede	*Leschius mcallisteri*	Arthropod	SC	none	IO
Lewis' woodpecker	*Melanerpes lewis*	Bird	SC	none	B
Loggerhead sea turtle	*Caretta caretta*	Reptile	ST	FT	IO
Loggerhead shrike	*Lanius ludovicianus*	Bird	SC	FCo	B
Lynx	*Lynx canadensis*	Mammal	ST	FT	IO
Makah copper	*Lycaena mariposa charlottensis*	Butterfly/Moth	SC	FCo	IO
Mann's Mollusk-eating Ground Beetle	*Scaphinotus mannii*	Other Insect	SC	none	IO
Marbled murrelet	*Brachyramphus marmoratus*	Bird	ST	FT	B
Mardon skipper	*Polites mardon*	Butterfly/Moth	SE	FC	IO
Margined sculpin	*Cottus marginatus*	Fish	SS	FCo	IO
Mazama (Western) pocket	*Thomomys mazama*	Mammal	ST	FC	IO

Common Name	Scientific Name	Animal Type	State	Federal	Mapping Criteria
gopher					
Merriam's shrew	*Sorex merriami*	Mammal	SC	none	IO
Mountain sucker	*Catostomus platyrhynchus*	Fish	SC	none	IO
Northern abalone	*Haliotis kamtschatkana*	Mollusk	SC	FCo	IO
Northern goshawk	*Accipiter gentilis*	Bird	SC	FCo	B
Northern leopard frog	*Rana pipiens*	Amphibian	SE	FCo	IO
Northern Spotted Owl	*Strix occidentalis*	Bird	SE	FT	IO
Olympia oyster	*Ostrea lurida*	Mollusk	SC	none	none
Olympic marmot	*Marmota olympus*	Mammal	SC	none	IO
Olympic mudminnow	*Novumbra hubbsi*	Fish	SS	none	IO
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	Butterfly/Moth	SE	FT	IO
Oregon spotted frog	*Rana pretiosa*	Amphibian	SE	FC	IO
Oregon vesper sparrow	*Pooecetes gramineus affinis*	Bird	SC	FCo	B
Pacific clubtail	*Gomphus kurilis*	Other Insect	SC	none	IO
Pacific cod (S&C Puget Sound)	*Gadus macrocephalus*	Fish	SC	FCo	IO
Pacific hake (Pacific-Georgia Basin DPS)	*Merluccius productus*	Fish	SC	FCo	IO
Pacific harbor porpoise	*Phocoena phocoena*	Mammal	SC	none	RSC
Pacific herring	*Clupea pallasi*	Fish	SC	FCo	none
Peregrine falcon	*Falco peregrinus*	Bird	SS	FCo	B,RI
Pileated woodpecker	*Dryocopus pileatus*	Bird	SC	none	B
Poplar oregonian	*Cryptomastix populi*	Mollusk	SC	none	IO
Preble's shrew	*Sorex preblei*	Mammal	SC	FCo	IO
Puget blue	*Plebejus icarioides blackmorei*	Butterfly/Moth	SC	none	IO
Purple martin	*Progne subis*	Bird	SC	none	B
Pygmy rabbit	*Brachylagus idahoensis*	Mammal	SE	FE	IO
Pygmy whitefish	*Prosopium coulteri*	Fish	SS	FCo	IO
Quillback rockfish	*Sebastes maliger*	Fish	SC	FCo	IO
Redstripe rockfish	*Sebastes proriger*	Fish	SC	none	IO
River lamprey	*Lampetra ayresi*	Fish	SC	FCo	IO
Rocky Mountain Tailed Frog	*Ascaphus montanus*	Amphibian	SC	FCo	IO
Sage sparrow	*Amphispiza belli*	Bird	SC	none	B
Sage thrasher	*Oreoscoptes montanus*	Bird	SC	none	B
Sagebrush lizard	*Sceloporus graciosus*	Reptile	SC	FCo	IO
Sand-verbena moth	*Copablepharon fuscum*	Butterfly/Moth	SC	none	IO
Sandhill crane	*Grus canadensis*	Bird	SE	none	B,RLC
Sea otter	*Enhydra lutris*	Mammal	SE	FCo	B,RI,RSC
Sei whale	*Baleonoptera borealis*	Mammal	SE	FE	IO
Sharptail snake	*Contia tenuis*	Reptile	SC	FCo	IO
Shepard's parnassian	*Parnassius clodius shepardi*	Butterfly/Moth	SC	none	IO
Short-tailed albatross	*Diomedea albatrus*	Bird	SC	FE	none
Silver-bordered fritillary	*Boloria selene atrocostalis*	Butterfly/Moth	SC	none	IO
Slender-billed white-breasted nuthatch	*Sitta carolinensis aculeata*	Bird	SC	FCo	IO
Snowy plover	*Charadrius alexandrinus*	Bird	SE	FT	B
Sockeye salmon (Ozette Lake)	*Oncorhynchus nerka*	Fish	SC	FT	none
Sockeye salmon (Snake R.)	*Oncorhynchus nerka*	Fish	SC	FE	none

Common Name	Scientific Name	Animal Type	State	Federal	Mapping Criteria
Sperm whale	*Physeter macrocephalus*	Mammal	SE	FE	IO
Steelhead (Lower Columbia)	*Oncorhynchus mykiss*	Fish	SC	FT	none
Steelhead (Middle Columbia)	*Oncorhynchus mykiss*	Fish	SC	FT	none
Steelhead (Puget Sound)	*Oncorhynchus mykiss*	Fish	none	FT	none
Steelhead (Snake River)	*Oncorhynchus mykiss*	Fish	SC	FT	none
Steelhead (Upper Columbia)	*Oncorhynchus mykiss*	Fish	SC	FT	none
Steller sea lion	*Eumetopias jubatus*	Mammal	ST	FT	RSC
Streaked horned lark	*Eremophila alpestris strigata*	Bird	SE	FC	B
Striped whipsnake	*Masticophis taeniatus*	Reptile	SC	none	IO
Tacoma pocket gopher - Mazama	*Thomomys mazama tacomensis*	Mammal	ST	FC	IO, RC
Taylor's checkerspot	*Euphydryas editha taylori*	Butterfly/Moth	SE	FC	IO
Tiger rockfish	*Sebastes nigrocinctus*	Fish	SC	none	IO
Townsend's big-eared bat	*Corynorhinus townsendii*	Mammal	SC	FCo	B,CR
Townsend's ground squirrel	*Urocitellus townsendii townsendii*	Mammal	SC	FCo	IO, RC
Tufted puffin	*Fratercula cirrhata*	Bird	SC	FCo	RLC
Umatilla dace	*Rhinichthys umatilla*	Fish	SC	none	IO
Upland sandpiper	*Bartramia longicauda*	Bird	SE	none	B,RI
Valley silverspot	*Speyeria zerene bremnerii*	Butterfly/Moth	SC	FCo	IO
Van Dyke's salamander	*Plethodon vandykei*	Amphibian	SC	FCo	IO
Vaux's swift	*Chaetura vauxi*	Bird	SC	none	B,CR
Walleye pollock (So. Puget Sound)	*Theragra chalcogramma*	Fish	SC	FCo	IO
Washington ground squirrel	*Urocitellus washingtoni*	Mammal	SC	FC	IO, RC
Western gray squirrel	*Sciurus griseus*	Mammal	ST	FCo	IO
Western grebe	*Aechmophorus occidentalis*	Bird	SC	none	B
Western pond turtle	*Actinemys marmorata*	Reptile	SE	FCo	IO
Western toad	*Anaxyrus boreas*	Amphibian	SC	FCo	IO
White-headed woodpecker	*Picoides albolarvatus*	Bird	SC	none	B,RI
White-tailed jackrabbit	*Lepus townsendii*	Mammal	SC	none	IO
Widow rockfish	*Sebastes entomelas*	Fish	SC	none	IO
Wolverine	*Gulo gulo*	Mammal	SC	FCo	IO
Woodland caribou	*Rangifer tarandus*	Mammal	SE	FE	IO
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	SC	FC	B,RI
Yelloweye rockfish	*Sebastes ruberrimus*	Fish	SC	FT	IO
Yellowtail rockfish	*Sebastes flavidus*	Fish	SC	none	IO
Yuma skipper	*Ochlodes yuma*	Butterfly/Moth	SC	none	IO

TABLE A-8. A COMPLETE LIST OF SPECIES UNDER THE PACIFIC COAST GROUNDFISH EFH (90 SPECIES)

Arrowtooth Flounder

Aurora Rockfish

Bank Rockfish

Big Skate

Black Rockfish - North

Black-And-Yellow Rockfish

Blackgill Rockfish

Blue Rockfish

Bocaccio

Bronzespotted Rockfish

Brown Rockfish

Butter Sole

Cabezon - South

Calico Rockfish

California Scorpionfish

California Skate

Canary Rockfish

Chameleon Rockfish

Chilipepper Rockfish

China Rockfish

Copper Rockfish

Cowcod

Curlfin Sole

Darkblotched Rockfish

Dover Sole

Dusky Rockfish

Dwarf-Red Rockfish

English Sole

Finescale Codling

Flag Rockfish

Flathead Sole

Freckled Rockfish

Gopher Rockfish

Grass Rockfish

Greenblotched Rockfish

Greenspotted Rockfish

Greenstriped Rockfish

Halfbanded Rockfish

Harlequin Rockfish

Honeycomb Rockfish

Kelp Greenling - Oregon

Kelp Rockfish

Leopard Shark

Lingcod

Longnose Skate

Longspine Thornyhead

Mexican Rockfish

Olive Rockfish

Pacific Coast Groundfish (All Species)

Pacific Cod

Pacific Ocean Perch

Pacific Rattail

Pacific Sanddab

Pacific Whiting

Petrale Sole

Pink Rockfish

Pinkrose Rockfish

Pygmy Rockfish

Quillback Rockfish

Ratfish

Redbanded Rockfish

Redstripe Rockfish

Rex Sole

Rock Sole

Rosethorn Rockfish

Rosy Rockfish

Rougheye Rockfish

Sablefish

Sand Sole

Sharpchin Rockfish

Shortbelly Rockfish

Shortraker Rockfish

Shortspine Thornyhead

Silvergrey Rockfish

Soupfin Shark

Speckled Rockfish

Spiny Dogfish

Splitnose Rockfish

Squarespot Rockfish

Starry Flounder

Starry Rockfish

Stripetail Rockfish

Swordspine Rockfish

Tiger Rockfish

Treefish

Vermilion Rockfish

Widow Rockfish

Yelloweye Rockfish

Yellowmouth Rockfish

Yellowtail Rockfish

TABLE A-9. A COMPLETE LIST OF SPECIES UNDER THE WEST COAST SALMON EFH (76 SPECIES)

California Central Valley Chinook

Cedar River Summer / Fall (Lake Washington) (ESA Threatened 1999)

Central and Northern Oregon (Aggregate of Fall and Spring stocks in all streams from the Elk River to

Central California Coast (ESA Threatened 1996)

Coastal Stocks

Columbia River (Natural) (Proposed ESA Threatened 2004)

Columbia River Basin Chinook

Columbia River Early (Hatchery)

Columbia River Late (Hatchery)

Eastern Strait of Juan De Fuca (streams east of Salt Creek through Chimacum Creek)

Eastern Strait of Juan De Fuca Summer / Fall (ESA Threatened 1999)

Eel, Mattole, Mad, and Smith Rivers (Fall and Spring) (Eel, Mattole and Mad River Stocks - ESA

Fraser River (British Columbia, Canada)

Grays Harbor

Grays Harbor Fall

Grays Harbor Spring

Green River Summer / Fall Threatened (1999)

Hoh

Hoh Fall

Hoh Spring / Summer

Hoko Summer / Fall (Western Strait of Juan De Fuca)

Hood Canal

Klamath River Fall (Klamath and Trinity Rivers)

Klamath River Spring (Klamath and Trinity Rivers)

Klickitat, Warm Springs, John Day, and Yakima Rivers (Spring)

Lower River Hatchery Fall

Lower River Hatchery Spring

Mid-River Bright Hatchery (Fall)

Nisqually River Summer / Fall (South Puget Sound) (ESA Threatened 1999)

Nooksack Spring (Early) (ESA Threatened 1999)

North Lewis River Fall (ESA Threatened 1999)

Northern California Coast Chinook

Northern California(ESA Threatened 1997)

Oregon Coast Chinook

Oregon Coastal Natural comprised of Southern, South-Central, North-Central, and Northern Oregon

Oregon Production Index Area Coho

Pink (Odd-Numbered Years)

Puget Sound

Puget Sound Chinook

Puget Sound Coho

Queets

Queets Fall

Queets Spring / Summer

Quillayute Fall

Quillayute Spring / Summer

Quillayute Summer (Hatchery)

Quinault (Hatchery)

Quinault Fall

Sacramento River Fall

Sacramento River Spring (Central Valley Spring - ESA Threatened 1999)

Sacramento River Winter (ESA Endangered 1994)

Skagit

Skagit Spring (ESA Threatened 1999)

Skagit Summer / Fall (ESA Threatened 1999)

Skokomish Summer / Fall (Hood Canal) (ESA Threatened 1999)

Snake River Fall (ESA Threatened 1992)

Snake River Spring / Summer (ESA Threatened 1992)

Snohomish

Snohomish Summer / Fall(ESA Threatened 1999)

South Puget Sound (Hatchery)

Southern British Columbia Chinook

Southern British Columbia Coast Coho

Southern Oregon (Aggregate of Fall and Spring stocks in all streams south of Elk River, Rogue River

Spring Creek Hatchery Fall

Stillaguamish

Stillaguamish Summer / Fall (ESA Threatened 1999)

Upper River Bright (Fall)

Upper River Spring (ESA Endangered 1999)

Upper River Summer

Upper Willamette Spring (ESA Threatened 1999)

Washington Coast Chinook

Washington Coastal Coho

Western Strait of Juan De Fuca (Sekiu, Hoko, Clallam, Pysht, East and West, and Lyre Rivers and

White River Spring (ESA Threatened 1999)

Willapa Bay Fall (Hatchery)

Willapa Bay Fall (Natural)

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