BIOLOGICAL ASSESSMENT

PHASE I OF THE TERMINAL 4 REMOVAL ACTION
PORT OF PORTLAND, PORTLAND, OREGON

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μg/L	micrograms per liter
Action Memo	*Action Memorandum for a Removal Action at the Port of Portland Terminal 4 Site within the Portland Harbor Superfund Site, Portland, Multnomah County, Oregon*
AOC	Administrative Order on Consent for Removal Action
BA	Biological Assessment
BEBRA	Bank Excavation and Backfill Remedial Action
BMP	Best Management Practice
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFR	Code of Federal Regulations
Corps	U.S. Army Corps of Engineers
CRD	Columbia River Datum
CWA	Clean Water Act
cy	cubic yards
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
DPS	Distinct Population Segment
DRET	dredging elutriate test
EE/CA	Engineering Evaluation/Cost Analysis
EFH	Essential Fish Habitat
EPP	Environmental Protection Plan
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FCRPS	Federal Columbia River Power System
GPS	Global Positioning System
h:v	horizontal to vertical
HPAH	high polycyclic aromatic hydrocarbon
LWD	Large Woody Debris
mg/L	milligrams per liter
ML	Maximum Levels
MSFCMA	Magnuson Stevenson Fisheries Management and Conservation Act

NBEMG	National Bald Eagle Management Guidelines
NFH	National Fish Hatchery
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPL	National Priorities List
NTCRA	Non-Time-Critical Removal Action
NTU	nephelometric turbidity unit
ODFW	Oregon Department of Fish and Wildlife
OHW	ordinary high water
OHWM	ordinary high water mark
OLW	ordinary low water
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	Primary Constituent Element
PEC	probable effects concentration
pg/L	picograms/liter
Port	Port of Portland
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
SFA	Sustainable Fisheries Act
SL	Screening Levels
SP&S	Spokane, Portland, and Seattle
TEC	threshold effects concentration
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geologic Service
VCP	Voluntary Cleanup Program
WQMCCP	Water Quality Monitoring Conditions and Compliance Plan

1 EXECUTIVE SUMMARY

This Draft Biological Assessment (BA) was prepared in accordance with Section 7(c) of the Endangered Species Act (ESA) regarding the potential effects on federally listed fish, wildlife, and plant species and their habitats for Phase I of a Removal Action to address contaminated sediments at the Port of Portland (Port) Terminal 4 on the Willamette River in Portland, Oregon. Phase I of the Removal Action includes 1) dredging at Berth 411, downstream of Berth 414, and adjacent to Pier 5; 2) dredging at Berth 410; 3) placement of a cap at the head of Slip 3; and 4) shoreline stabilization in Wheeler Bay; and (Figure 3). "Berth 411 Plus" will be used throughout the remainder of this document to describe dredging activities at Berth 411, downstream of Berth 414, and adjacent to Pier 5. The USEPA is requiring the Port to implement this Phase of work during the 2008 in-water work window to reduce risks present at the Terminal 4 site (USEPA 2007). Terminal 4 is located within the Portland Harbor Superfund Site (Superfund Site), which is on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*. (CERCLA or Superfund).

The proposed activities include those described in the Action Memorandum for the Removal Action (USEPA 2006), including the work to be performed as part of Phase I and are considered a federal agency action under the Endangered Species Act (ESA), which are required to substantively comply with the Endangered Species Act (USEPA 2006). This BA serves, in part, as consultation with National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) in providing an Effects Analysis and Determination for effects of Phase I to evaluate compliance with ESA requirements. Conservation measures are identified in the BA to avoid and minimize adverse effects of the project. In addition, this BA provides an Effects Analysis and Determination for Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act (SFA).

The general purpose of the Phase I activities is to remove material with the highest surface sediment probable effects concentration (PEC) exceedance ratios (greater than 20 times the PEC) in the Berth 411 Plus dredging areas, isolate petroleum-contaminated sediment at the head of Slip 3, remove a potential future contaminant source to sediments along the Wheeler Bay shoreline, and eliminate a navigational impediment at Berth 410 in a manner that is consistent with USEPA's Action Memo.

The Head of Slip 3 cap (Figures 3 and 4) and the Wheeler Bay shoreline stabilization (Figures 3 and 5 through 8) are intended to be the final removal action for these areas, consistent with the 2006 USEPA-selected Removal Action. The Berth 411 Plus dredge areas and Berth 410 dredge area (Figures 3 and 9) will be reassessed and, if necessary, addressed as part of Phase II of the Removal Action implementation (i.e., final Removal Action activities), along with Slip 1, the remaining portions of Wheeler Bay, and the remaining portions of Slip 3 and the area downstream of Berth 414 within the Removal Action Area.

1.1 ESA Listed Species Addressed in this BA

The listed fish species that may occur in the vicinity of the proposed project site include fourteen Evolutionarily Significant Units (ESUs) and Distinct Population Segments (DPSs) of anadromous salmonids. ESA-listed species and critical habitat that may occur in the Action Area are given in Table ES-1.

Table ES-1
Federally Listed Species and Critical Habitat that May Occur in the Action Area

Species and Evolutionary Significant Unit (ESU) or Distinct Population Segment (DPS)	Federal Status	Critical Habitat
Chinook Salmon (*Oncorhynchus tshawytscha*)		
Upper Columbia River ESU	Endangered	Designated
Snake River spring/summer Chinook ESU	Threatened	Designated
Snake River fall-run Chinook ESU	Threatened	Designated
Lower Columbia River ESU	Threatened	Designated
Upper Willamette River ESU	Threatened	Designated
Coho Salmon (*O. kisutch*)		
Lower Columbia River ESU	Threatened	Not Applicable (under development)
Chum Salmon (*O. keta*)		
Columbia River ESU	Threatened	Designated
Steelhead (*O. mykiss*)		
Snake River Basin DPS	Threatened	Designated
Upper Columbia River DPS	Threatened	Designated
Middle Columbia River DPS	Threatened	Designated
Lower Columbia River DPS	Threatened	Designated
Upper Willamette River DPS	Threatened	Designated
Sockeye Salmon (*O. nerka*)		
Snake River ESU	Endangered	Designated
Bull Trout (*Salvelinus confluentus*)		
Columbia River ESU	Threatened	None Designated in Willamette or Columbia Rivers

1.2 Effect Determinations

In assessing the potential effects of the proposed project on listed fish, wildlife, and plant species and their habitats, the environmental baseline was documented, the proposed actions were evaluated to assess the effect on the environmental baseline, and the results of these evaluations were used to arrive at a determination of effect. Emphasis in the effects analysis was placed on short-term and localized sediment disturbance, water quality effects, and benthic invertebrate disturbance associated with project work, all as described in detail in Section 7. Indirect, interrelated, interdependent, and cumulative effects of the various project components were also considered.

For this project, there are separate effect determinations for the listed fish species that are likely to occur in the Willamette River near where in-water work will occur versus the

Columbia River near the offloading location. Effect determinations from the project on listed species and associated critical habitat are listed in Table ES-2.

Table ES-2
Summary of Effect Determinations

Species and Evolutionary Significant Unit (ESU) or Distinct Population Segment (DPS)	Listed Species Effect Determination	Critical Habitat Effects Determination
Chinook Salmon (*Oncorhynchus tshawytscha*)		
Upper Columbia River ESU	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Snake River spring/summer Chinook ESU	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Snake River fall-run Chinook ESU	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Lower Columbia River ESU	Likely to adversely affect	May affect, not likely to adversely affect
Upper Willamette River ESU	Likely to adversely affect	May affect, not likely to adversely affect
Coho Salmon (*O. kisutch*)		
Lower Columbia River ESU	Likely to adversely affect	None designated
Chum Salmon (*O. keta*)		
Columbia River ESU	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Steelhead (*O. mykiss*)		
Snake River Basin DPS	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Upper Columbia River DPS	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Middle Columbia River DPS	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Lower Columbia River DPS	Likely to adversely affect	May affect, not likely to adversely affect
Upper Willamette River DPS	Likely to adversely affect	May affect, not likely to adversely affect
Sockeye Salmon (*O. nerka*)		
Snake River ESU	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Bull Trout (*Salvelinus confluentus*)		
Columbia River ESU	May affect, not likely to adversely affect	None designated

The basis for the "likely to adversely affect" conclusions for listed species are that the likelihood of the potential effects cannot be entirely discounted in the short term, their extent cannot be labeled as insignificant, and their overall benefits are not contemporaneous; thus, a "may affect, likely to adversely affect" determination is appropriate.

The basis for the "may affect, not likely to adversely affect" conclusions for listed species are that potential project effects may occur ("may affect"), but are expected to be insignificant and are not anticipated to reach the scale where take occurs, or are discountable and extremely unlikely to occur ("not likely to adversely affect"). Take will not occur because effects are not expected to cause significant habitat modification, significant impairment or disruption of normal behavioral patterns, or increase the likelihood of injury to listed species.

The basis for the "may affect, not likely to adversely affect" conclusions for critical habitat is that potential project effects will occur ("may affect"), but are not expected to jeopardize the continued existence of an endangered or threatened salmon or steelhead ESU or result in the destruction or adverse modification of critical habitat.

No federally listed wildlife species are known to occur in the vicinity of the project action area. Several listed plant and bird species known to occur in the Willamette River basin (plants: Golden paintbrush, Willamette River daisy, Howellia, Bradshaw's lomatium, Kincaid's Lupine, and Nelson's checker mallow; birds: Yellow-billed cuckoo, Streaked horned lark) were determined not to warrant further analysis because they are not present in the Lower Willamette River near Terminal 4. In addition, several fish species that may occur in the Action Area have been considered for listing under the ESA, but were determined not to warrant listing (Pacific lamprey [*Lampetra tridentate*] and coastal cutthroat [*Oncorhynchus clarki clarki*]). Bald eagles were recently removed from the endangered species list as the final rule went into effect on August 8, 2007, and are now primarily protected under the Eagle Act and the National Bald Eagle Management Guidelines (NBEMG; USFWS 2007). Since the closest bald eagle nest is nearly 2 miles from the proposed dredging site, this project will be in compliance with the NBEMG and no actions to protect eagles will be necessary.

In addition, based on consideration of the EFH requirements of the Coastal Pelagic Species (CPS) fishery, West Coast groundfish fishery, and the Pacific coast salmon fishery, the potential direct, indirect, and cumulative effects of the proposed project actions **may adversely affect Pacific Coast Salmon EFH and West Coast Groundfish EFH**. The implementation of appropriate conservation measures would help minimize impacts to EFH for these species. No significant long-term effects to EFH are anticipated. Long-term beneficial effects to EFH are expected as a result of the project based on the reduction of sediment contamination from the EFH environment.

2 INTRODUCTION AND BACKGROUND

This document presents the Biological Assessment (BA) for Phase I of a Removal Action to address contaminated sediments at the Port of Portland (Port) Terminal 4 on the Willamette River in Portland, Oregon. The activities described in this BA, previously called "Abatement Measures," are referred to as Phase I of the Removal Action as they are part of the phased approach of implementation of the Action Memorandum (USEPA 2006). Phase I of the Removal Action includes dredging within the Berth 410 area as well as dredging within the Berth 411 Plus dredging areas as shown on Figure 3. The purpose of dredging in these areas differs by area and is detailed in Section 2.1. Terminal 4 is located within the Portland Harbor Superfund Site (Superfund Site), which is on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*. (CERCLA or Superfund).

The activities described in the Action Memorandum for the Removal Action (USEPA 2006), including the work to be performed during Phase I, are considered a federal agency action under the Endangered Species Act (ESA) and are required to substantively comply with the ESA. The ESA of 1973 (as amended) requires protection of threatened and endangered species and their habitats. Section 7(a)(2) of the ESA requires that "each Federal agency shall, in consultation with and with the assistance of the Secretary, ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section." Section 7 of the ESA further requires that for a major construction activity, the action agency must submit a BA if listed species or designated critical habitat may be present in the Action Area (see Section 2.3 of this document for a description of the Action Area).

This BA provides an Effects Analysis and Determination for effects of Phase I of the Removal Action on federally listed species for the purpose of evaluating compliance with the substantive requirements of the ESA (USEPA 2006). In addition, this BA provides an Effects Analysis and Determination for Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery

Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act (SFA) (Appendix A). Under this legislation, an EFH evaluation of impacts is necessary for activities that may adversely affect EFH. EFH is defined by the MSFCMA in 50 Code of Federal Regulations (CFR) 600.905-930 as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and is designated for groundfish, coastal pelagic, and Pacific salmon composites.

The following sections provide an overview of the project purpose and the project area, as well as listed species to be evaluated.

2.1 Purpose and Need of Proposed Activities

2.1.1 Abatement Measure

In May 2006, the U.S. Environmental Protection Agency (USEPA), in consultation with its federal, state, and tribal partners, evaluated and selected a Non-Time Critical Removal Action (NTCRA or Removal Action) for Terminal 4. The Removal Action selection was detailed in the USEPA Action Memorandum issued on May 11, 2006 (Action Memo; USEPA 2006) and included a combination of monitored natural recovery, capping, and dredging with placement of contaminated sediments in a confined disposal facility (CDF) to be built on site. In December 2006, the Port submitted the 60 Percent Design for the Removal Action, and since that time, the Port and USEPA teams have been working collaboratively through technical questions and issues associated with the design. However, some design and timing issues are linked to the overall harbor-wide Remedial Investigation/Feasibility Study (RI/FS) process, and as such, the USEPA has agreed to revise the schedule for implementation of the Terminal 4 Removal Action to realign the project with the harbor-wide RI/FS schedule (USEPA 2007).

As a condition of the approval of the schedule realignment, the USEPA is requiring the Port to implement an abatement action during the 2008 in-water work window to reduce risks present at the Terminal 4 site (USEPA 2007). Essentially, this results in division of the Removal Action project into two phases. Phase I (the abatement action) is planned for the 2008 in-water work window. Phase II (including construction of the

CDF) will commence once the project is realigned with the harbor-wide RI/FS process. This BA only addresses Phase I of the Removal Action. Final design and implementation of Phase II (the final phase of the Removal Action) is dependent upon information from the harbor-wide investigation and will be conducted once that information is available. A separate federal consultation will occur, and a new BA will be prepared for Phase II of the Removal Action.

Phase I of the Removal Action was scoped with the following objectives for abatement measures:

- Measures are consistent with USEPA's selected removal action in the Action Memo (USEPA 2006)
- Measures will significantly reduce ecological and human health risks at the Removal Action Area in a timely manner
- Measures will not unduly impede or disrupt the designated use of Terminal 4 for water-dependent maritime use.

Phase I of the Removal Action, as described in further detail in Section 3, meets these project objectives by:

- Dredging and off-site disposal of sediments exhibiting the highest chemical concentrations
- Construction of a nearshore cap to isolate petroleum-contaminated sediments from aquatic receptors and control a potential ongoing source to nearby areas
- Stabilization of a portion of the bank to minimize contaminant migration to the river
- Dredging and off-site disposal of contaminated sediments in Slip 3 within the navigation berth area of high ship traffic that requires regular maintenance

In addition, dredging and off-site disposal of contaminated sediments in Slip 3 at Berth 410 was added to the Phase I work to support water-dependent maritime use in a manner consistent with the Action Memo and in support of overall risk reduction in the Removal Action Area

2.1.2 Dredging

There are two dredge areas identified for dredging: Berth 411 Plus and Berth 410 (Figure 3). The Berth 411 Plus dredge area was identified for dredging for Phase I implementation because this area represents the highest concentrations of sediments within the Removal Action Area (Anchor 2007). The purpose of the Phase I dredging is to abate imminent and substantial endangerment posed to aquatic life that may have direct contact with sediments within the Removal Action Area. The highest risk surface sediments (i.e., surface sediments with probable effects concentration [PEC} exceedance ratios greater than 20) within the Removal Action Area are generally located at the head of the slip and at an area north of Berth 414 (Figure 7). Removal of these highest risk sediments will provide a permanent solution of contaminant mass removal, remove the highest risk surface sediments, and contribute to the future ecological recovery of the Removal Action Area.

The Berth 410 area was identified for dredging as part of Phase I of the Removal Action because dredging is necessary to maintain navigable water depths for deep draft cargo vessels that call at these berths. The vast majority of this dredge footprint is within the area identified by USEPA for dredging in the Action Memo as part of the Removal Action. However, because the complete Removal Action (previously anticipated to occur in 2008) has now been postponed to realign with the harbor-wide RI/FS schedule, dredging is needed to maintain navigable water depths for deep draft cargo vessels that call at Berth 410. Incorporating this dredging into Phase I of the Removal Action eliminates the navigational impediment at Berth 410 in a manner that is consistent with USEPA's Action Memo.

Sediment accumulation at the Terminal 4 berthing area requires dredging approximately every 2 years or less. The Port is statutorily authorized to operate and maintain shipping facilities and is required by shipping agreements to maintain suitable navigational depths for clients that load and offload cargo at the terminal. Terminal 4 serves as an important water-dependent import and export cargo access point for deep draft vessels that call at the Port. Recent Port surveys have shown Berth 410 requires immediate dredging to remove river sediments accumulating above authorized navigational depth clearances. The proposed project would allow deep draft vessels to safely access berthing areas using the full authorized depth.

In addition to meeting the goal of implementing the Removal Action selected by USEPA in the Action Memo (USEPA 2006), dredging within this area would continue to support the economic benefits of the marine terminal facility, including maintenance of export shipping capacity from the region. Incorporating the Berth 410 dredging with Phase I activities planned for the area will have the additional benefit of reducing the environmental impact relative to completing these activities as separate tasks, including minimizing impacts to water quality.

2.2 Project Setting

The project is located at the Port's Terminal 4 Facility (Terminal 4) at 11040 North Lombard Street in Portland, Oregon (Figure 1). Terminal 4 is within or adjacent to the Superfund Site on the eastern shore of the Willamette River downstream of the St. Johns Bridge and between River Miles (RMs) 4 and 5.

The Willamette River is a tributary to the Columbia River at approximately RM 102. It is the 10th largest river in the contiguous United States in terms of streamflow. The Willamette Basin is 11,460 square miles in size and constitutes 12 percent of the land area of Oregon (WRI 1999). The Willamette Basin is divided into 12 subbasins. The lower reach of the Willamette River—the subbasin that includes the City of Portland—extends from the mouth upstream to the falls at Oregon City (RM 26.5 of the Willamette River). Land uses within the Lower Willamette River watershed in the vicinity of Portland and its suburbs are urban/industrial, residential, and rural/agricultural. Many of the state's heaviest industrial users are present in the Lower Willamette watershed. As a result, development has caused the removal of optimal habitat characteristics for juvenile salmonids, including extensive off-channel wetland and shallow water beach areas for rearing and resting.

Terminal 4 in the Lower Willamette River is an active marine terminal with a high volume of commercial and recreational traffic, and as such, undergoes periodic dredging and other maintenance activities associated with terminals of this type. Land use surrounding

Terminal 4 is industrial. The upland area comprises about 283 acres (Parsons Brinkerhoff 2002) including the Toyota lease areas, and is generally flat in grade in proximity to the slips. The surface covering is primarily asphalt, with minor areas of gravel and/or ballast associated with the rail lines. The Engineering Evaluation/Cost Analysis (EE/CA) Work Plan (BBL 2004a) summarized local conditions and this information is included in the Environmental Baseline (Section 6) of this BA.

In general, physical habitat conditions in the Action Area (see Section 2.3 for a definition of Action Area) and vicinity are degraded for many habitat elements considered for listed species. The Action Area lies within a highly active area of the Portland Harbor and Portland metropolitan area, and is within the Industrial Sanctuary as designated by the City of Portland's Comprehensive Plan. As a result, physical development (e.g., shoreline modification and dredging) and high disturbance (e.g., vessel traffic and ship wakes) that would be expected for these areas are present.

2.3 Removal Action Area and Action Area

The terms "Removal Action Area" and "Action Area" are used in this BA to discuss geographic areas relevant to the project. The former is a project boundary previously defined in the Administrative Order on Consent (AOC), while the latter includes those areas potentially affected by the proposed project (Figure 2).

The Removal Action Area is defined by the AOC as follows: "…that portion of the Site adjacent to and within the Port of Portland's Terminal 4 at 11040 North Lombard, Portland, Multnomah County, Oregon: extending west from the ordinary high water line on the northeast bank of the lower Willamette River to the edge of the navigation channel, and extending south from the downstream end of Berth 414 to the downstream end of Berth 401, including Slip 1, Slip 3, and Wheeler Bay." Site is defined by the AOC as follows: "…the Portland Harbor Superfund Site, in Portland, Multnomah County, Oregon, listed on the NPL on December 1, 2000. 65 Fed. Reg. 75179-01. The Site consists of the areal extent of contamination, including all suitable areas in proximity to the contamination necessary for implementation of response action, at, from and to the Portland Harbor Superfund Site Assessment Area from approximately River Mile 3.5 to River Mile 9.2 (Assessment Area), including upland portions of the Site that contain sources of contamination to the sediments at, on or within the Willamette River…" Under the EE/CA, the *Site Characterization Report* (BBL 2004b) divided the Terminal 4 Removal Action Area into subareas based on an initial evaluation of sediment chemistry and operational and engineering considerations, as follows:

- Berth 401
- Slip 1 (This slip includes Berths 405 and 408)
- Wheeler Bay
- Slip 3 (This slip includes Berths 410 and 411 and Pier 5)
- North of Berth 414

A summary of the Phase I of the Removal Action is depicted on Figure 3, and shows these locations.

The Action Area is defined as the area to be affected directly or indirectly by the federal action (50 CFR §402.02). The basis for the Action Area takes into consideration project activities that pose potential impacts to listed species and their habitats. For this project, these activities include dredging and capping, which can result in the temporary resuspension of sediments or contaminants in the water column.

For purposes of this BA, the Action Area is defined as follows: the mainstem Willamette River aquatic area in the vicinity of the Terminal 4 Removal Action Area, to include 0.25 miles upstream of Portland/Vancouver and downstream 0.5 miles (Figure 2). At the time of submittal of this BA, the choice of a specific disposal facility has not yet been made for dredged material from this project; however, the disposal facility will likely be one of several subtitle D landfills located upstream of Terminal 4 on the Columbia River. As a result, the action area identified in this document has been expanded to include the federally authorized navigation channel transport corridor down the Willamette River to the Columbia River, and upstream on the Columbia River to a potential offloading facility, and listed species that may occur in the Columbia River have been added to this document. It should be emphasized that no in-water work or discharge of any material (water, solid, or otherwise) will occur in the Columbia River and that these additional species would only be affected in the event of an accidental spill during transportation or offloading. Thus, the Action Area also includes the mainstem Columbia River aquatic area in the vicinity of the (to be chosen) offloading location, to include 0.25 miles upstream of the location and downstream 0.5 miles.

The Action Area distances described in the previous paragraph are set to be conservative based on a potential worst-case dispersion of turbidity and any associated contaminants during a single tidal cycle, although it is expected that any turbidity increases would rapidly dissipate. Although the Action Area is broadly defined here to include the transport corridor and offloading area in order to set the extent of potential effects to listed species, most effects are generally expected to be confined to the area adjacent to the points of dredging and capping. Thus, Figure 2 does not show the Columbia River portion of the Action Area.

2.4 Listed Species and Evaluation Methods

Table 1 summarizes species that are listed under the ESA and that may occur in the vicinity of Terminal 4[1] and along the transport corridor and vicinity of the offloading area. The species given in these tables were obtained from U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) most current species lists and online materials (NMFS 2007 [Appendix B]; USFWS 2006).

[1] The ESA defines a "species" to include any distinct population segment (DPS) of any species of vertebrate fish or wildlife. For Pacific salmon, NMFS considers an Evolutionarily Significant Unit (ESU) a "species" under the ESA. For Pacific steelhead, NMFS has delineated DPSs for consideration as "species" under the ESA.

Table 1
Federally Listed Species and Critical Habitat in the Action Area

Species and Evolutionary Significant Unit (ESU) or Distinct Population Segment (DPS)	Federal Status	Critical Habitat
Chinook Salmon (*Oncorhynchus tshawytscha*)		
Upper Columbia River ESU	Endangered	Designated
Snake River spring/summer Chinook ESU	Threatened	Designated
Snake River fall-run Chinook ESU	Threatened	Designated
Lower Columbia River ESU	Threatened	Designated
Upper Willamette River ESU	Threatened	Designated
Coho Salmon (*O. kisutch*)		
Lower Columbia River ESU	Threatened	Not Applicable (under development)
Chum Salmon (*O. keta*)		
Columbia River ESU	Threatened	Designated
Steelhead (*O. mykiss*)		
Snake River Basin DPS	Threatened	Designated
Upper Columbia River DPS	Threatened	Designated
Middle Columbia River DPS	Threatened	Designated
Lower Columbia River DPS	Threatened	Designated
Upper Willamette River DPS	Threatened	Designated
Sockeye Salmon (*O. nerka*)		
Snake River ESU	Endangered	Designated
Bull Trout (*Salvelinus confluentus*)		
Columbia River ESU	Threatened	None Designated in Willamette or Columbia Rivers

In evaluating potential effects to these species, this BA compiles the best available scientific and commercial data for the proposed project and considers the current environmental baseline, species information, and key habitat elements in the vicinity of Terminal 4 that may be affected by the proposed action. Factors considered include effects to listed species, the species' biological requirements and life history information, habitat components and conditions within the project vicinity, distribution and abundance of listed species, the potential for impacts to critical habitat, and the ability to minimize and mitigate for potential adverse effects. The methods outlined in *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996) and the *Endangered Species Consultation Handbook* (USFWS and NMFS 1998) were used as guides to analyze potential effects. The effects determinations made here are based on this information, and use this information to determine whether the proposed action is likely to adversely affect listed species or designated critical habitat.

Several listed plant species (Golden paintbrush, Willamette River daisy, Howellia, Bradshaw's lomatium, Kincaid's Lupine, and Nelson's checker mallow) and bird species (Yellow-billed cuckoo and Streaked horned lark) were initially investigated for consideration during this analysis, but they were determined not to warrant further analysis based on the conclusions of recent BAs (Oregon DEQ and USEPA 2002; Port of Portland and EES 2004a and 2004b; Anchor 2005) completed for projects in the vicinity of Terminal 4, which reported that these species are not present in the Lower Willamette River near Terminal 4. Based on these previous determinations of their absence in the vicinity of Terminal 4, no further discussion of these plant or wildlife species is included in this BA.

Several fish species that may occur in the Action Area have been considered for listing under the ESA, but were determined by the USFWS not to warrant listing. Pacific lamprey (*Lampetra tridentata*) was petitioned for listing, but it was determined on December 20, 2004 that Pacific lamprey is not a listable entity[2]. In addition, the southwestern Washington/Columbia River DPS of coastal cutthroat (*Oncorhynchus clarki clarki*) was considered for listing, but on July 5, 2002, the proposed rule was withdrawn due to improved understanding of the abundance of these populations (USFWS 2002).

Bald eagles were recently removed from the endangered species list as the final rule went into effect on August 8, 2007. Bald eagles are now primarily protected under the Eagle Act, which makes it illegal to kill, wound, pursue, shoot, shoot at, poison, capture, trap, collect, molest, or disturb bald or golden eagles. To avoid potential disturbance to bald eagles, the National Bald Eagle Management Guidelines (NBEMG; USFWS 2007) provide recommendations that will likely avoid take for a list of activities. Recommendations are

[2] The *Finding on a Petition to List Three Species of Lampreys as Threatened or Endangered Species* found that "[n]either the information presented in the petition nor that available in Service files presents substantial scientific or commercial information to demonstrate that the Pacific lamprey located in the lower 48 states is a listable entity. Accordingly, we are unable to define a listable entity of the Pacific lamprey. Since the population of Pacific lamprey cannot be defined as a DPS at this time, thus ineligible to be considered for listing, we did not evaluate its status as endangered or threatened on the basis of either the Act's definitions of those terms or the factors in section 4(a) of the Act" (USFWS 2004).

provided in the form of setback distances from nest sites depending on the specific activity in question and whether or not the nest is within the line of site of the proposed construction activity. If disturbance will occur in potential violation of the act, a permit to authorize take of eagles is required.

Currently, there is no formal process or requirement for consultation under the Eagle Act, but information related to compliance with the NBEMG is provided here for documentation purposes. The closest reported nest sites to the proposed project activities are located at Smith Lake, approximately 1.9 miles east of the Terminal 4 project area and not in line of sight of the project, and on Ross Island, approximately 9 miles south of the Action Area. Since the closest bald eagle nest is nearly 2 miles from the proposed dredging site, this project will be in compliance with the NBEMG and no permit will be necessary.

2.5 Project Timing

The proposed activities are anticipated to occur between July and October 31, 2008. Based on current information on dredge and cap volumes, in-water work is expected to span 4 weeks, and the total project is expected to occur over 6 weeks. As stated above, in-water work for this project will comply with the timing restrictions associated with the in-water work window that has been specified by the Oregon Department of Fish and Wildlife (ODFW 2000) to correspond to times when salmonids are expected to be either not present or present only in very low numbers. In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31.

More specific information related to construction sequencing is provided in Section 4.

3 PROJECT DESCRIPTION

This section describes Phase I of the Removal Action as agreed to by the USEPA (USEPA 2007), including methods for construction and measures that will be taken to reduce impacts to listed species.

3.1 General Activities

Phase I of the Removal Action includes 1) dredging in the Berth 411 Plus areas; 2) placement of a cap at the head of Slip 3; 3) shoreline stabilization in Wheeler Bay; and 4) dredging at Berth 410 (Figure 3). The general purpose of these activities is to remove material with the highest surface sediment PEC exceedance ratios (greater than 20 times the PEC) in the Berth 411 Plus dredging areas, isolate petroleum-contaminated sediment at the head of Slip 3, remove a potential future contaminant source to sediments along the Wheeler Bay shoreline, and eliminate a navigational impediment at Berth 410 in a manner that is consistent with USEPA's Action Memo.

The Head of Slip 3 cap (Figures 3 and 4) and the Wheeler Bay shoreline stabilization (Figures 3 and 5 through 8) are intended to be the final removal action for these areas, consistent with the 2006 USEPA-selected Removal Action. The Berth 411 Plus and Berth 410 dredging areas (Figures 3 and 9) will be reassessed and, if necessary, addressed as part of Phase II of the Removal Action implementation (i.e., final Removal Action activities), along with Slip 1, remaining portions of Wheeler Bay, and the remaining portions of Slip 3 and the area North of Berth 414 within the Removal Action Area.

Phase I of the Removal Action is illustrated in Figures 3 to 14 and described in detail in Sections 3.2 – 3.4.

3.1.1 Conservation Measures

General conservation measures that will be applied to the Phase I activities include the following:

- In-water work for this project will comply with the timing restrictions specified in the in-water work window that has been specified by ODFW (2000), when salmonids are expected to be either not present or present only in very low numbers. In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31.

- Operations will be stopped temporarily if listed species are observed as injured, sick, or dead in the project area, to determine whether additional fish are present and to ensure that operations may continue without further impact. NMFS Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death or injury.
- Construction barges will be situated in areas of sufficient depth so as to not ground out during low water conditions.
- The Port will prepare a dredged and stockpiled material handling plan detailing best management practices (BMPs) that will be implemented to minimize the potential for off-site tracking of contaminated sediments while stockpiled and during transport to the landfill.
- The project will adhere to water quality protection conditions and monitoring found in the Water Quality Monitoring Conditions and Compliance Plan (WQMCCP) that will be issued by USEPA for this action. Because the WQMCCP is not available at the time of submittal of this BA, it is understood that water quality monitoring stated in the WQMCCP will be incorporated into the conservation measures of the Biological Opinion so that there are no inconsistent requirements between the Biological Opinion and WQMCCP. USEPA and the Port have agreed upon water quality monitoring details, which were approved by USEPA in the Abatement Measures Proposal submitted to USEPA in October. Specific details from the Abatement Measures Proposal are provided in subsequent sections of this document for each specific construction activity.
- Prior to entering the water, all equipment will be checked for leaks and completely cleaned of any external petroleum products, hydraulic fluid, coolants, and other deleterious materials.
- A spill containment and control plan will be kept on site during construction activities and will contain notification procedures, specific cleanup and

placement instructions for different products, quick response containment and cleanup measures that will be available, proposed methods for placement of spilled materials, and employee training for spill containment.

- The contractor will establish an Environmental Protection Plan (EPP), which prevents environmental pollution and minimizes environmental degradation during and as a result of construction operations, including consideration of noise levels, air, water, and land. The EPP will establish and maintain quality control for environmental protection of all proposed actions. Erosion and turbidity control measures will also be included in the EPP.

3.2 Dredging

3.2.1 Dredging in the Berth 411 Plus Areas

The purpose of dredging in the Berth 411 Plus areas is to remove surface sediments exhibiting the highest concentrations of chemicals of concern within the Removal Action Area and dispose of them at a USEPA-approved upland landfill. This will accomplish two key sediment cleanup objectives: 1) eliminate exposure to the highest risk surface sediments within the Removal Action Area before Phase II of the Removal Action is implemented; and 2) eliminate a significant mass of contaminated sediments from the Removal Action Area. For the purpose of Phase I of the Removal Action, the highest risk surface sediments are defined as those with PEC exceedance ratios greater than 20.

Figure 9 shows the dredge footprints within the Berth 411 Plus areas based on surface sediment PEC exceedance ratio greater than 20. These target footprints will be removed down to dredge elevations established using existing and proposed cores located within the footprints. The dredge elevations will be set to remove materials above a PEC exceedance ratio of 10 within the footprints. Based on current information, the dredge cuts will vary in thickness between 1 and 3 feet within the footprints shown on the drawings. Additional cores are being collected within these footprints to provide a higher density of information on which to base the design and refine the dredge elevation (Figure 10). As previously mentioned, the current expected depth of removal is between 1 and 3 feet of material within the identified dredge areas based on existing information (Figure 11). If the additional data to be collected suggests that these depths need to be adjusted, the information will be provided to NMFS in January 2008 as an addendum to the BA.

The dredge prism will be further refined during the design of Phase I of the Removal Action based on additional data and further sheetpile wall stability analysis, but the dredge cuts are expected to extend out to the boundary of the dredge prism with temporary side slopes of 3H:1V to 2H:1V up from the design dredge elevation to the daylight line. For sheetpile wall stability, geotechnical analyses have concluded that dredging deeper than -46 feet National Geodetic Vertical Datum (NGVD) within 50 feet of the sheetpile wall will compromise its stability. Therefore, no dredging is proposed below elevation -46 feet NGVD within 50 feet of the sheetpile wall (Figure 12). The Port plans to update the sheetpile wall geotechnical stability analysis to assess the feasibility of dredging all 20 times the PEC material. If, based on pre-construction data, newly exposed surface concentrations in the area are predicted to be higher than the target (20 times the PEC), one option would be to place a sand layer of approximately 6 inches over this area (volumes are currently estimated at 2,500 cubic yards [cy] of sand, but these estimates may change depending on sediment core sampling results).

Based on current information, the final dredge surface is expected to be:

- Head of Slip 3: Will depend on core results, but finished elevations are expected to be between approximately -45 feet and -50 feet NGVD (existing elevations are typically between -43 feet and -45 feet NGVD)
- Area adjacent to Pier 5: Will depend on core results, but a 2 to 3 foot dredge cut is expected, resulting in a finished elevation between approximately -40 feet to -42 feet NGVD (existing elevations are between -38 feet and -39 feet NGVD).
- Area North of Berth 414: Will depend on core results, but a 2 to 3 foot dredge cut is expected, resulting in a finished elevation between approximately -18 feet and -28 feet NGVD (existing elevations are between -16 feet and -25 feet NGVD).

Approximately 7,400 – 8,400 cy is expected to be removed for this dredging, covering an area of 50,110 square feet.

3.2.2 Dredging at Berth 410

Berth 410 is currently used to load soda ash (sodium carbonate) for export and is located within Slip 3, part of the Removal Action Area designated for dredging in the Action Memo. As previously stated, sediment accumulation at Berth 410 requires dredging every 2 or fewer years to ensure continued use of the berths by deep draft cargo vessels. Dredging of Berth 410 was most recently performed in 2005, removing approximately 4,000 cy of sediments. Recent surveys of the berthing area indicate that current depths range from -34.3 feet NGVD (-36 feet Columbia River Datum [CRD]) to -58.3 feet NGVD (-60 feet CRD). The purpose of dredging in this area is to remove a navigation impediment at Berth 410 in a manner consistent with USEPA's Action Memo.

Dredging activities to service Berth 410 are illustrated in Figures 13 and 14. This area generally does not coincide with the area with the highest concentrations of contaminants that is proposed for dredging as Phase I of the Removal Action. Table 2 provides a summary of the existing chemistry data for samples collected within the Berth 410 dredging area and Appendix C contains the actual sample results. Based on this information, the chemical concentrations for the existing surface are generally less than 1 times the PEC for metals, except for one location towards the east end of the dredge area close to the Berth 411 dredge area where concentrations reach up to 4.3 times the PEC (T4-B411-01). In addition, the surface chemical concentrations for PAHs range from 1.8 (HC-S-35) to 2.8 (T4-B411-01) times the PEC. The proposed in-water action for 2008 includes dredging to the proposed design depth of –40.3 feet NGVD (-42 feet CRD) (based on current bathymetric surveys), plus a 2-foot overdredge allowance, for a total maximum depth of -42.3 feet NGVD (-44 feet CRD). Based on the existing sampling data provided in Table 2 (from locations shown on Figure 10) within the dredge area, the final dredge surface chemical concentrations should be less than or equal to the existing surface concentrations. The exception to this interpretation is the east end of the dredge area near the Berth 411 dredge area that may have higher PAH concentrations exposed after dredging. The existing data in this location does not extend deep enough to determine the post-dredge leave surface below -41.7 feet NGVD. However, the expected concentrations if dredging went deeper than this elevation would be less than or comparable to adjacent surface sediments (e.g., HC-S-20 contains

PAH concentrations up to 16 times the PEC). Additional core data is currently being analyzed to confirm these interpretations associated with the existing data.

Table 2
Summary of Data within the Berth 410 Dredge Areas - Existing and Proposed Surfaces

Sample ID	Mudline Elevation of Sample (feet NGVD)	Analytes	Existing Surface PEC EF	Proposed Surface PEC EF (between -40. 3 feet NGVD and -42.3 feet NGVD)	Summary Comments
HC-S-30	-43.4 to -43.7	NA	NA	NA	Below the overdredge depth, sample not used
HC-S-35	-39.2 to -39.5	Metals	<1	NA	Existing surface has chemical concentrations less than the PEC concentration; no data at this location to evaluate post-dredge leave surface.
		PAHs	<1 to 1.8	NA	
HC-S-37	-39.8 to -40.1	Metals	<1	NA	Existing surface has chemical concentrations less than the PEC concentration; no data at this location to evaluate post-dredge leave surface.
		PAHs	<1	NA	
T4-01-1A	-40.3 to -41.3	Metals		<1	No chemical concentrations greater than the PEC concentration within the proposed dredge prism surface. Post-dredge leave surface not expected to have chemical concentrations above PEC concentrations in this location.
		PAHs		<1	
		DDTs		<1	
T4-01-1B	-41.3 to -42.3	DDTs		<1	
		PCBs		<1	
T4-01-1C	-42.3 to -43.3	DDTs		<1	
		PCBs		<1	
T4-01-2A	-40.3 to -41.3	Metals		<1	Chemical concentrations for metals, DDTs, and PCBs are all less than PEC concentrations within the proposed dredge prism. PAH concentrations decrease with depth from target dredge depth (-40.3 feet NGVD) to the overdredge depth (-42.3 feet NGVD).
		PAHs		<1 to 8.4	
		DDTs		<1	
		PCBs		<1	
T4-01-2B	-41.3 to -42.3	PAHs		<1 to 1.7	
		DDTs		<1	
		PCBs		<1	
T4-01-2C	-42.3 to -43.3	PAHs		<1	
T4-01-3A	-40.3 to -40.8	Metals		<1 to 8.5 (Lead)	Do not have information to determine the post-dredge leave surface below -40.8 feet NGVD.
		PAHs		<1	
		DDTs		<1	
		PCBs		<1	
T4-B411-01	-40 to -41	Metals	<1 to 4.3 (Lead)		Do not have data to determine the post-dredge leave surface below -41.7 feet NGVD. If dredging is completed at elevations above -41.7 feet NGVD, there may be a potential for higher PAH concentrations up to 8.3 times the PEC. However, these concentrations are lower than adjacent surface sediment concentrations (e.g., HC-S-20--data indicates PAH concentrations up to 16 times the PEC).
		PAHs	<1 to 2.8		
		DDTs	0		
		PCBs	0		
T4-B411-01	-41 to -41.7	Metals		<1 to 3.4 (Lead)	
		PAHs		<1 to 8.3	
		DDTs		<1	
		PCBs		<1	

In addition to consistency with the Action Memo, the proposed dredge depth will achieve a more sustainable dredging program in minimizing the overall impacts to the aquatic environment in Slip 3 by reducing the frequency of dredging. Specifically, the Port anticipates that the proposed depth will relieve the need for annual dredging for at least several years until Phase II of the Removal Action is implemented. Additionally, after dredging is completed, concentrations of contaminants are expected to be less than 10 times the PEC, which is consistent with the Phase I of the Removal Action.

Approximately 5,200 to 10,000 cy of material is proposed to be removed over 75,000 square feet for the proposed dredging Berth 411 Plus area described here.

3.2.3 Construction Methods for Dredging and Offloading

Dredging would be completed using mechanical methods (clamshell buckets). Specifically, the clamshell bucket would be suspended from a crane mounted on a barge. The weight of the open bucket allows it to grab bottom sediments. The sediments would be placed in either a flat-deck barge with watertight sideboards or a in bin-barge with one or multiple cells. No in-water rehandling would be performed.

The depth of the bucket would be monitored by markings on the cable holding the bucket and the dredge would be equipped with a positioning computer system (HYPACK, WINOPS, or similar) specifically designed to allow the operator to remove the correct amount of material from the correct location. This system enables the operator to compare recent hydrographic survey data with boat-mounted depth sounder readings to monitor their relative progress and adjust accordingly. The position of the bucket would be determined and displayed by the system in real-time using a global positioning system (GPS).

The sediments removed during dredging would be placed on a barge equipped to hold dredged material and water, and transported by barge or a combination of barge and truck/train to an USEPA-approved landfill for disposal. The contractor will arrange and coordinate the offloading-site, which is expected to be located on the Columbia River, upstream of the confluence with the Willamette River. At this site, the material on the barge would either be offloaded and treated to reduce water in the sediment prior to placement into trucks or railcars or would be offloaded directly into trucks or railcars for transportation to an approved landfill. If testing reveals that the material is suited for daily cover, such beneficial use will be sought at that time. Depending on water content of the sediments and external factors such as weather, an additive may be added to the dredged material to absorb excess water that would be disposed of with the dredged material. Alternatively, excess water may be released into a municipal sanitary sewer with the approval of the municipality and in compliance with any permit. In addition, the trucks or rail cars may be lined with plastic sheeting to ensure that no release of water or sediments will occur during transportation. Conservation measures (Section 3.2.4) will be followed during transport of dredge material to prevent inadvertent releases of sediments or contaminants.

Post-dredge surveys will be performed to confirm contractor estimates of sediments removed from the target areas and to ensure that target depths are achieved. If the post-dredge survey shows that areas were missed, the contractor will remove those sediments with additional dredging. A final post-dredge survey will be used to calculate the actual river sediment quantities that were removed.

3.2.4 Conservation Measures for Dredging and Offloading

Conservation measures will be applied to dredging and transportation activities that occur as part of Phase I. These include:

- An appropriate dredge sequencing strategy will be employed to minimize sediment with higher contamination levels from dispersing into adjacent areas. Specifically, dredging is expected to begin at the head of Slip 3 and work towards the mouth, as the head of the Slip contains material with the highest chemical concentrations, and concentrations generally decrease towards the mouth.
- Experienced dredge operators will be required.
- Contractor vessel draft and movement will be controlled within dredge areas during construction to limit the potential for scour.
- During transport and handling of sediment, adequate containment measures and inspections will be employed to minimize spillage.

- Slopes will be dredged beginning with the highest elevation of material to be removed and working toward the lowest elevation.
- Slopes will be dredged between cuts and adjacent to slopes as designed (i.e., slopes will not be oversteepened during dredging).
- The contractor will be required to do a surface debris survey prior to dredging.
- Dredging equipment will not be allowed to ground.
- A GPS will be used to ensure material removal from the proper locations will be used for correct bucket location during dredging.
- The dredge bucket will be swung directly to the haul barge after it breaks the surface, using minimal swing distance. Pausing the dredge bucket as it breaks the surface of the water will not be allowed.
- Bottom or beach stockpiling will not be allowed
- Taking multiple bites with the clamshell bucket will not be allowed.
- Overfilling of the bucket will not be allowed.
- Standard barge loading controls will be observed including no barge overfilling (less than 85 percent capacity). The barge would be loaded so that enough of freeboard remains to allow for safe movement of the barge and its material on its planned route.
- Use of a bin-barge or flat-deck barge with watertight sideboards and cover to enclose dredged material, including dredged sediment and water.
- No material shall be allowed to leak from the bins or overtop the walls of the barge.
- Metal spill aprons, upland spill control curbing and collection systems, and other spill control measures will be used when transferring material from the haul barges to the transloading facility. If a bucket is used to offload dredged material from the barge, a dribble apron would be used to catch and collect any material dropped during offloading operations. No material would be allowed to re-enter the river at the offloading facility.
- Equipment such as fuel hoses, oil drums, oil or fuel transfer valves and fittings will be checked regularly for drips or leaks, and shall be maintained to prevent spills to the river.

- No water will be created or discharged. Any free liquid remaining in the haul barge will be removed and contained for appropriate disposal.
- Dock curbing will be used to prevent any potential spill material and rainwater from entering the river.
- The clamshell bucket, once over land, will be emptied into a hopper to funnel material directly into lined trucks or rail cars. Trucks or rail cars will be water tight and covered during transport to the disposal facility. Trucks would be loaded on disposable pads/tarps and underloaded to minimize loss during transport. Routine visual inspections of the loading area and access routes will be performed. Caution will be exercised so that material does not leak out of the vehicles, slosh over the tops, or be blown off during transport from the offloading facility to the final disposal site.
- The transfer area and all equipment used in transfer activities will be cleaned and decontaminated.
- The dredged material will be disposed of in a manner consistent with its characterization. Large pieces of recyclable material that may be removed with sediments may be taken to an approved recycling center. Dredge material will be transported to an approved upland landfill. No material will be allowed to re-enter any waterway at the offloading site.
- Dewatering of sediments will occur either in a barge or at an approved upland facility. If the elutriate is dewatered in a barge, the water will be released into a municipal sanitary sewer system, pursuant to applicable discharge requirements.
- No surface water releases of dredge elutriate material to the Columbia River will occur.
- To discourage any migrating salmonids that may be in the area from entering Slip 3 during key construction activities or work in areas with the highest chemical concentrations, a passive fish deterrent system that minimizes fish handling and associated additional stresses will be used. The deterrent system is described below in Section 3.2.4.1.
- In addition to these measures, other conservation measures may be required during dredging, as described in Section 3.2.4.2.

3.2.4.1 Fish Deterrent System

The intent of the system will be to lead fish migrating downstream along the shoreline back out into the river. The dimensions of the system will be targeted at deterring juvenile salmonids. The system will consist of two components extending from the river bank out into the river. The first component will function as a leader that guides downstream migrating fish away from the mouth of Slip 3. The leader will be a 10-foot-wide panel intended to guide fish in the top 10 feet of the water column and will be made of knotless nylon net mesh material of an appropriate size so as not to impinge or gill juvenile salmonids down to a size of 40 mm. The mesh netting will be colored such that juvenile fish will be able to see it in the water column. The mesh leader net will extend from the bank at the south end of the mouth of Slip 3 approximately 160 to 180 feet into the river at an approximate 45 degree angle from the bank, pointing in the downstream direction. The overall leader set up will consist of two net panels that are 80 to 90 feet in length, each extending 10 feet into the water column. Two panels will be used rather than one to facilitate daily inspection, and cleaning, if necessary, of the mesh panels. Floats will be placed on the top of the nets and a lead line on the bottom to keep the net upright. The first mesh panel will extend from an anchor point on the shoreline downstream into the channel at a 45 degree angle to an existing dolphin structure where the other end will be secured. The second mesh panel will be tied to the dolphin structure and will extend downstream at a 45 degree angle towards the harbor line. The end of this panel will have a 50 foot line and anchor holding it to the bottom, and will be marked on the surface by a large buoy signaling to shipping traffic of the obstruction in the water. The nets will be maintained daily, including visual inspection and removal of any accumulated debris and to confirm that the system remains in place. It is anticipated that the water quality monitoring crew would perform the daily maintenance checks.

The deployment configuration of the mesh leader panels is depicted on Figure 15. The figure also illustrates how fish swimming downstream along the leader are expected to be diverted approximately 160 to 180 feet from the shoreline along which they naturally tend to follow. Juvenile fish migrating along shorelines naturally have to move around obstructions such as rock outcroppings, shoreline changes, and embayments that force them to swim at an angle to the current. It is expected that the fish will swim around this placed diversion as they would a natural diversion. Diverting them away from the shoreline will discourage them from entering the Slip, and will result in them being more in the open channel at the mouth of the Slip. Downstream currents will then serve as the primary migratory guiding influence once they reach the end of the mesh leader, helping facilitate their migration past Slip 3 and back along the shoreline. To discourage any fish from migrating towards the Slip at the end of the mesh leaders, a second component of the deterrent system will also be deployed as described below.

The second component will be a bubble curtain that will be placed across the mouth of Slip 3 to be an additional deterrent from entering the Slip. The curtain will be comprised of an air hose that lies on the bottom of the river bed across the mouth of Slip 3. The hose will have holes in it from which air will escape that is pumped into the air hose from an air compressor situated on the adjacent shoreline. It is anticipated that to create an effective bubble curtain, the system may require multiple manifolds along the depth of the water column in order to maintain coverage from deeper depths to the surface of the water. The approximate location of the bubble curtain is also depicted in Figure 15.

The mesh panel and bubble curtain will be deployed during dredging at Berth 411 and adjacent to Pier 5, as well as during placement of a cap at the head of Slip 3. These measures will not be in place during dredging at Berth 410 as the bubble curtain would intersect the dredging area and its interference with dredging operations would make it impossible to function properly. As described in Section 6.3.1, the sediments in the Berth 410 area pose much lower contaminant concentrations than the other areas.

Although the fish deterrent system discussed above does not propose to capture fish, the leader net concept has been used for years for fisheries related research to guide fish into capture nets (Nielsen and Johnson 1983), and it is therefore expected that the leader net would fulfill the same function here to guide fish along the shore and out of Slip 3. Salmonids have a tendency to lead along a visible net without attempting to pass through the mesh, especially if the net is set obliquely to the shore so that fish will lead along the net with a gradual change in direction and will be less inclined to attempt to pass through the net (Stober et al. 1983). Passive-capture devices such as trap nets commonly use leaders attached to the mouth to intercept moving fish; when fish follow the leader in an attempt to get around the netting, they swim into the enclosure (Nielsen and Johnson 1983). Very long leaders on trap nets have also been used to guide fish from large estuarine areas into a sampling enclosure (Bottom et al. 2005).

3.2.4.2 Description of Additional Conservation Measures

During dredging activities, the contractor and field crew will be required to monitor water quality standards in the project area to be compared against all applicable water quality standards, including turbidity and total suspended solids (TSS; standards will be defined more specifically in the WQMCCP, but are expected to be compared to both pre-construction ambient water quality survey results and results from ongoing monitoring at the upstream background reference station).

The compliance boundary and early warning boundary for TSS and turbidity for dredging and transport activities in Slip 3 will be 100 meters and 50 meters, respectively, from the mouth of Slip 3. The compliance and early warning boundaries for all other parameters (chemical contaminants, dissolved oxygen [DO], pH, and temperature) for dredging in Slip 3 will be 100 meters and 50 meters, respectively, from the dredging activity. The compliance and early warning boundaries for dredging and transport activities occurring downstream of Berth 414 for all parameters will be 100 meters and 50 meters, respectively, from the construction activity.

If water quality measurements at the compliance boundary during dredging exceed the criteria defined more specifically in the WQMCCP, a sequence of responses will be initiated, including implementation of additional controls to be determined as needed. The details and sequence of the steps will be presented in the WQMCCP and the Water Quality Monitoring Plan for construction, but will generally include notifying USEPA and repeating measurements at specified time intervals after the exceedance is first detected, to confirm the exceedance or show that water quality criteria are no longer being exceeded. The construction contractor will then take corrective action as necessary in order to meet standards.

Due to the physical configuration of Slip 3, (deep water perpendicular to the river, irregular bathymetry (ranging from -36 to -60 feet CRD) and potential vessel traffic in the dredging area, operational controls (as opposed to a silt curtain or similar device) are considered the most effective measure for control of turbidity during dredging. Examples of possible corrective actions are provided below:

- Reduce the velocity of the ascending loaded bucket through the water column, which reduces the potential to wash sediment from the bucket and reduces the sediment loading into the water column over a set period of time. Limiting the velocity of the descending bucket, on the other hand, may reduce the volume of sediment that is picked up by the bucket due to reduced penetration, which would require more total bites to remove the project material, increasing the overall project and impact duration.
- Use Closed or Environmental Bucket where feasible. This technology consists of specially constructed dredging buckets designed to reduce turbidity from suspended solids from entering the water. Environmental buckets are not suitable in certain situations, including situations with sediments of medium or greater density.

3.3 Head of Slip 3 Cap

The location of the proposed Head of Slip 3 cap is shown on Figure 3. This area is adjacent to the location of a previous remediation (Bank Excavation and Backfill Remedial Action [BEBRA; Hart Crowser 2000]), which addressed a historic petroleum seep on the slope in 2004. However, petroleum-contaminated sediments remain in water below elevation 3 feet NGVD, and thus the purpose of the Head of Slip 3 cap is to address these impacted sediments and tie into the BEBRA work.

Figures 3 and 4 show the conceptual design of the Head of Slip 3 cap. Prior to doing the work, the contractor will construct a wedge against the outer edge of the existing wooden bulkhead to stabilize it; this area outside the bulkhead does not currently exhibit armor material. The wedge will consist of a 12-inch layer containing approximately 70 cy of Base Cap Type 1 (fine to medium sand) overlain by approximately 220 cy of Armor Type 3 material (small armor material). The wedge covers approximately 1,500 square feet. The armor material is necessary to provide stability for the wooden bulkhead and to prevent erosion from propeller wash at high water levels. The armor material will be constructed at a 1 horizontal to 1 vertical (1H:1V) slope against the timber bulkhead.

After the bulkhead is stabilized, the contractor will begin working upslope of the bulkhead. First, the contractor will remove the existing riprap and filter blanket at the toe of the BEBRA as needed to expose the existing sand and organoclay unit. Once the bank is exposed, Base Cap Type 3 material (10 parts sandy gravel to gravelly sand mixed with 1 part organoclay) will be placed against the existing sand fill/organoclay unit and on the slope down towards the timber bulkhead. The Base Cap Type 3 material will be isolated with a layer of filter material and armor material placed on top. Base Cap Type 3 material will be 10 parts Base Cap Type 2 material (sandy gravel to gravelly sand) mixed with 1 part organoclay (dry weight). Based on current information, capping is expected to occur between elevations +2 feet and +6 feet NGVD with final elevations expected as approximately 1 foot higher (ranging from +3 to +7 feet NGVD). Approximately 435 cy of material, including 100 cy of filter material, 85 cy of Base Cap Type 3 material, and 250 cy of armor is proposed to be placed over the currently armored area of 6,100 square feet.

3.3.1 Construction Methods for Capping

Cap materials will be placed mechanically either from the upland using upland construction equipment, or from a barge using a clamshell bucket (clamshell will be used for areas below the existing timber bulkhead). For each lift, the bucket will be cracked above the water surface while moving side to side to spread the material. The material will be placed with sufficient control to meet the design thickness.

Following the placement of the cap, a bathymetric survey of capped aquatic areas will be completed to verify and document that the cover meets the specification. Excavated riprap material that is contaminated (expected to be approximately 200 cy) will either be loaded directly to a barge or contained on site in a stockpile, which will then be loaded to a truck or barge for transport to an appropriate landfill for disposal.

3.3.2 Conservation Measures for Capping

Conservation measures that will be applied to this work include:

- To ensure proper cap placement, in-situ cap materials will be placed in a controlled and accurate manner, slowly releasing the material from a clamshell bucket rather than dropping it in larger amounts. The placement will occur starting at lower and working to higher elevations.
- Set volume, tonnage, lead line measurements, and bathymetry information will be used to verify adequate coverage during and following material placement. Sediment cap materials will be imported, clean, granular material free of roots, organic material, contaminants, and all other deleterious material.
- Surface booms, oil-absorbent pads, and similar materials will be on site for any sheens that may occur on the surface of the water during construction.
- If there is contaminated excavated material following construction that requires stockpiling and landfill disposal, proper sediment and erosion control methods will be implemented to contain the material and prevent any material from re-entering the waterway.
- The same conservation measures will be applied to material that is transported to the disposal landfill and offloaded as is described in Section 3.2.4.

In addition to these measures, other conservation measures may be required during capping. The contractor and field crew will be required to monitor water quality in the project area to be compared against all applicable water quality standards, including turbidity and TSS (standards will be defined more specifically in the WQMCCP, but are expected to be compared to both pre-construction ambient water quality survey results and results from ongoing monitoring at the upstream background reference station).

The compliance boundary and early warning boundary for TSS and turbidity for capping activities in Slip 3 will be 100 meters and 50 meters, respectively, from the mouth of Slip 3. The compliance and early warning boundaries for all other parameters (chemical contaminants, DO, pH, and temperature) for capping in Slip 3 will be 100 meters and 50 meters, respectively, from the capping activity.

If water quality measurements at the compliance boundary during capping exceed the criteria defined more specifically in the WQMCCP, a sequence of responses will be initiated, including implementation of additional controls to be determined as needed. The details and sequence of the steps will be presented in the WQMCCP and the Water Quality Monitoring Plan for construction, but will generally include notifying USEPA and repeating measurements at specified time intervals after the exceedance is first detected, to determine whether the exceedance is confirmed or that water quality criteria are no longer being exceeded. The construction contractor will then take corrective action as necessary in order to meet standards.

Due to the physical configuration of the Slip 3 (deep water perpendicular to the river), and potential vessel traffic in the dredging area, operational controls (as opposed to a silt curtain or similar device) are considered the most effective measure for control of turbidity during capping. For example, construction activities will be progressively slowed until turbidity exceedances are no longer detected outside of the compliance boundary, to minimize sediment suspension. This is similar to the measure of decreasing dredging cycle times to decrease turbidity plumes until the suspended sediment settles. Following slowing of capping activities, monitoring will continue, and operations will be modified in this manner until the plume dissipates.

3.4 Wheeler Bay Shoreline Stabilization

The Wheeler Bay shoreline is an area that is highly degraded, as the oversteepened banks along the entire length of the bay cause a high level of erosion which impacts the habitat conditions. Particularly at the northwest mouth of the bay, the shore exhibits large areas of slumping, and the substrate contains armor material. Concrete and other types of debris are also found throughout the shoreline. The remainder of the bay, with the exception of the southeast corner, contains sandy substrate and large woody debris on the beach, however this shore is also flanked by steep and eroding banks containing invasive plants. This area also generally lacks riparian cover. The southeast corner of the bay is characterized by extremely steep slopes with an armor cover that extends below the water's edge. The Phase I of the Removal Action will consist of stabilizing the shoreline through regrading the surface, planting and placement of landscape features to help with stabilization, and placement of armor material only in areas where the potential for erosion is high due to steepness or proximity to erosion generating forces. It is expected that the habitat condition of Wheeler Bay after Phase I activities are completed will be substantially improved over existing conditions as described in Table 3.

Table 3
Summary of Existing and Proposed Habitat Conditions along the Wheeler Bay Shoreline

Area	Elevation Range (feet NGVD)	Existing Conditions		Proposed Conditions	
		Area (sf)	Habitat Description	Area (sf)	Habitat Description
A and B	+10 to +15	50,300	Oversteepened slopes causing high degree of erosion and bank sloughing, including contaminated soil material. Scattered concrete and other debris across entire area. Invasive plant species in sparse arrangement, bare soils, and general lack of riparian cover or native species. In middle section of the Bay, there is a flat sandy beach area where LWD has collected; however, this area is flanked by oversteepened eroding slopes and is subject to the erosion and inputs of contaminated material that is occurring in the area.	19,500	LWD with rootballs to be placed oriented along the perimeter of the bay. LWD to increase habitat complexity and diversity and help stabilize the slope.
B	+10 to +12			7,000	Additional armor material necessary to protect against toe of slope and cap erosion and prevent contaminated material from entering the aquatic environment in Area B only.
A and B	+15 to +20			10,800	Native willow (live stakes) plantings to create riparian zone and cover, extending along the entire length of shoreline within the stabilization work area where oversteepened slopes have been regraded.
A and B	+20 to +30			13,000	Native grasses to improve plant community and stabilize topsoils, extending along the entire length of shoreline within the stabilization work area where oversteepened shorelines have been regraded.
C	+10 to +30	6,300	Armor material extending through an extremely steep sloped bank into the water in Area C	6,300	Additional armor material necessary to protect against cap erosion and prevent contaminated material from entering the aquatic environment in Area C.

In addition to habitat degradation, Wheeler Bay has been identified as a potential contaminant source to the nearshore sediments due to contaminants present, oversteepened banks, and the potential for erosion. Sampling results indicate elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), metals, DDD, DDE, and DDT based on samples collected on the slope along the shoreline (Ash Creek/Newfields 2007). Shoreline stabilization is proposed here to stop the current erosion and prevent further contamination from entering the aquatic environment. The proposed location for the shoreline stabilization work is along the majority of the Wheeler Bay shoreline (Figures 3 and 5). As part of the RI/FS and Source Control Measure Voluntary Cleanup Program (VCP) agreement between DEQ and the Port, the riverbank area was identified as requiring a source control measure for stabilization. The Terminal 4 Slip 1 Upland Facility boundary as defined in the VCP Agreement with the Department of Environmental Quality (DEQ) extends down to Ordinary Low Water (OLW), elevation 3.4 feet NGVD. The in-water work boundary defined for the Removal Action extends up to Ordinary High Water (OHW), elevation 16.6 feet NGVD.

A majority of the Phase I Removal Action work will encompass the area above elevation +10 feet NGVD as presented in the Terminal 4 Removal Action Design Analysis Report 60 Percent Design (Anchor 2006b) and the Abatement Measures Proposal (Anchor 2007). The elevation +10 feet NGVD was selected partially due to a lower likelihood of recontamination of stabilization materials placed above elevation 10 feet NGVD than below this elevation. Contaminated sediments exist in Wheeler Bay that will not be addressed as part of Phase I of the Removal Action, but rather during Phase II of the Removal Action. Resuspension of these materials during storm events, high currents, or ship activity could recontaminate caps placed below elevation 10 feet NGVD. Slip 3 dredging as part of the Phase II Removal Action could also potentially cause recontamination of aquatic caps within Wheeler Bay as well. Raising the elevation of the cap boundary as much as possible while still creating stable slopes minimizes the recontamination potential. In addition, constructing the stabilization work down to elevation 10 feet allows for stable slope configurations. A higher toe elevation would force a steeper, less stable slope, while a lower toe elevation is generally not required for stability. The potential for scour at the toe of the stabilization will be evaluated and addressed as part of the Phase I design.

Figure 5 identifies the location of the shoreline stabilization and Figure 6 presents cross sections through the stabilization areas. These figures also identify the aquatic cap that will be constructed at a later date as part of the Phase II Removal Action. As seen in Figure 6, most of the slope will be regraded to a more stable configuration. The bank excavation during regrading will be limited to 40 feet from the center of the existing rail alignment or a maximum distance of 25 feet from the top of the bank, whichever is more restrictive. Regrading will occur between elevations +30 feet NGVD to +10 feet NGVD and will occur in the dry. Grading and excavation will occur over 43,300 square feet, approximately half of which will need to be cleared and grubbed to remove concrete or other debris and invasive weeds before regrading.

Once the slope is graded to the design grade, a total of 4,300 cy of material is expected to be placed. This material will consist of approximately 2,000 cy of Base Cap Type 2 backfill material (sandy gravel to gravelly sand) placed between elevations +30 and +10 feet as necessary (cross sections B and C), and a final surface treatment of either armor material (24-inch; cross section C) or coir erosion control blanket between elevations +15 feet to +20 feet and jute mat between elevation +20 feet and +30 feet NGVD (cross sections A and B), in order to stem erosion (Figure 6). Approximately 1,000 cubic yards of armor material will be placed over approximately 13,300 square feet and jute mat and coir blanket will be placed over approximately 30,000 square feet. If there is any excess material after regrading, it will either be loaded directly to a barge or contained on site in a stockpile, which will then be loaded to a truck or barge for transport to an appropriate landfill for disposal. Armor material is necessary in steep areas for stability and in areas along the shoreline subject to erosion generated by the design river flow conditions and vessel-induced waves. The amount of armor material required has been minimized as much as possible with alternative engineering solutions (i.e., native willow plantings, hydroseeding, placement of large woody debris [LWD]), but some areas are too steep for these measures or need erosion protection and will require armor material. The alternative engineering solutions for stabilization are discussed in more detail below.

Almost all of the armor material to be placed in Wheeler Bay will occur at or above elevation +10 feet NGVD, in an area which is almost always above the river level.

Specifically, the armor material will cover 13,300 square feet between elevations +10 and +30 feet NGVD, which is approximately 30 percent of the total area to be regraded at Wheeler Bay. Currently, approximately half (6,300 square feet) of the area to be covered in armor material as part of Phase I currently consists of armor material, while the other half (7,000 square feet) of the area to be armored is characterized by sand/pebble substrate with debris. A minimal amount of armor material covering approximately 100 square feet will need to be placed down to elevation +8 feet NGVD to reach the toe of the slope as shown in Cap Section C (Figure 6). This area currently contains armor material at this elevation.

An analysis of USGS water level data from 1972 to 2004 and Hydrosphere Data from 1987 to 2004 showed that water levels in the Removal Action Area typically reach +9 to +10 feet less than 1 percent of the time from February to May/June, which overlaps the period that the highest concentrations of juvenile salmonids are expected to be in the Action Area (Anchor 2006a). Assuming a 1 percent frequency of inundation for this time period, the armor material would be inundated approximately 1.2 days on average during the 4 month time period. Based on mean monthly stage data for Portland, OR from 1973 to 2003 (same data source used in the water level analysis mentioned above), zero days of inundation are expected on average for the July through October time period (Corps of Engineers 2004). This time period corresponds to the time of year when the lowest concentration of juvenile fish is expected to be in the area. Additionally, for the November through February time period, mean monthly stage data indicates there would be zero days of inundation of armor material during this time period (Corps of Engineers 2004). Since this time of year is prone to storm activity, it is assumed that the armor would be inundated on the same frequency (1.2 days on average) as described for the February through June time period. Overall, it is expected that the armor material will be inundated for approximately 3 days on average throughout the year.

In addition to the stabilization work described above, native willow plantings (live stakes) will be installed in a band approximately 5 feet wide along the entire area of the shoreline stabilization area in Wheeler Bay between elevations +15 to +20 feet NGVD. The plantings will cover an area of approximately 10,800 square feet. Hydroseeding will occur in the jute mat in a band between elevations +20 to +30 NGVD covering an area of approximately

13,000 square feet. A two foot layer of high quality natural imported topsoil or a manufactured topsoil mix will be placed in areas where willow live stakes will be planted. In addition, 4- to 6-inches of mulch will be placed on top of the topsoil such that the total depth of this combined mulch and topsoil section will be approximately 28 to 30 inches. A temporary below ground irrigation system with sprinkler heads, automatic valves, and a controller, will be installed and will be available until the riparian vegetation is established.

LWD will also be installed along the shore perimeter of the bay between approximate elevations of +10 to +15 feet NGVD to occur within an area of approximately 19,500 square feet. These activities will help stabilize the shoreline and improve the degraded habitat conditions within Wheeler Bay. Figures 7 and 8 show 5 to 10 year post construction design solutions and the resulting habitat improvements in Wheeler Bay.

3.4.1 Construction Methods for Shoreline Stabilization

Clearing, grubbing, and regrading work will be accomplished in the dry using typical construction equipment, such as trackhoes and bulldozers. Some excess material from regrading may need to be stockpiled on site and transported to a suitable landfill for disposal. Any excess material after regrading will be contained on site in a stockpile and taken to an appropriate landfill for disposal in the same way as dredged material.

Because all work will occur above the expected river elevation during July through October, water quality monitoring for this activity is not required.

3.4.2 Conservation Measures for Shoreline Stabilization

The following conservation measures will be used during construction of the Wheeler Bay shoreline stabilization:

- Construction equipment will not be allowed to enter the water.
- Erosion control measures will be selected and implemented according to DEQ's *Sediment and Erosion Control Manual* (GeoSyntec 2005) and will remain in place during all of the shoreline activities to prevent material from entering the waterway.

- If there is excavated material following grading activities that requires stockpiling and landfill disposal, proper sediment and erosion control methods will be implemented to contain the material and prevent any material from entering the waterway.
- The same conservation measures will be applied to material that is transported to the disposal landfill and offloaded as is described in Section 3.2.4.

3.5 Monitoring Overview for Phase I Activities

Monitoring activities will be conducted for Phase I activities to evaluate the short-term impacts of construction and the effectiveness of conservation measures. The frequency and locations of this monitoring will be determined in cooperation with USEPA. This section provides an overview of expected short-term and long-term monitoring activities.

Monitoring that will occur covers several activities, as described in previous sections of this document, as follows:

- Water quality monitoring will be conducted during dredging, capping, and offloading, as described in Sections 3.2.4 and 3.3.2, above.
- Bathymetric and/or land-based surveys will be performed after dredging and capping to confirm that the specified elevations were met.
- Monitoring of the loading area and unloading area (if not at a landfill's offloading facility) will occur before and after all the transport work is completed to determine if contaminated materials were tracked off site during transport. During the Phase I design, the Port will prepare a dredged and stockpiled material handling plan that will include BMPs that will be implemented to minimize the potential for off-site tracking of contaminated sediments while stockpiled and during transport to the landfill. The monitoring activities will verify the effectiveness of the BMPs.

For the proposed dredging in the Berth 411 Plus and Berth 410 dredging areas, no long-term monitoring activities are proposed because this activity is not intended to be a final action, but an interim action. However, the area will be reassessed and addressed as part of Phase II of the Removal Action.

For the Head of Slip 3 cap, long-term monitoring is proposed because this work is expected to also serve as a final action for this area. Thus, long-term monitoring will occur and will be geared toward verifying the physical integrity of the cap and that the cap continues to function as designed, including bathymetric and visual surveys.

Shoreline stabilization in Wheeler Bay is also expected to be a final action for that area. Thus, long-term monitoring will also occur and will be completed in accordance with DEQ requirements for a soil management plan as part of the upland remedy, including inspections to evaluate the physical integrity of the stabilized area and erosion evaluation.

4 CONSTRUCTION SEQUENCING

The expected sequence of construction activities associated with the implementation of Phase I of the Removal Action and Berth 410/411 dredging is described below:

- A majority of the Head of Slip 3 cap and all of the Wheeler Bay shoreline stabilization work will occur from land. The placement of armor on the outside of the existing wood bulkhead in the Head of Slip 3 cap area is expected to occur from a barge rather than from land. These two activities will likely occur sequentially because the same crew will likely complete the work in these areas. The dredging work will occur from the water independently of the capping and shoreline stabilization work.
- The dredging work will be coordinated with the existing Slip 3 tenant to minimize disruptions to ongoing operations.
- The Head of Slip 3 cap work is expected to last approximately 2 weeks and to occur simultaneously with the dredging, which is expected to be completed in approximately 3 to 4 weeks, assuming work will occur 12 hours per day, 6 days per week.
- The Wheeler Bay shoreline stabilization work is expected to be completed after the Head of Slip 3 cap work within approximately 4 weeks.
- The overall expected duration of the construction activities is approximately 6 weeks based on current information.

5 SPECIES ACCOUNTS AND USE OF THE ACTION AREA

This section describes species life history information and biological requirements, factors limiting the species, and information about the presence of each federally listed species that may occur in the Action Area.

5.1 Pacific Salmonids

ESUs and DPSs of Pacific salmonids that may occur in the Action Area were listed in Table 1. This section defines range-wide biological requirements of these salmonids as well as ESU- or DPS-specific information. Available historical and relatively recent species information is summarized from NMFS' coast-wide status reviews (Busby et al. 1996; Johnson et al. 1997; Weitkamp et al. 1995). Both adult and juvenile salmonids would be expected to use the Action Area, as described below.

In general, adult salmonids would be expected to occur in the deeper water of the main river channel of the Action Area. Adults of various ESA-listed species would be present during most months of the year during their respective upriver migration periods. Adults typically follow river margins when returning to their natal streams, moving rapidly through shallow water, and resting in deep pools and areas with habitat structure (Spence et al. 1996). Some adults may hold for periods of time within the Portland Harbor (NMFS 2002), but no spawning occurs in the Action Area.

Juveniles would be expected to be present in the Action Area year-round, and would be expected to use both the nearshore and offshore portions of the Action Area depending on fish size, with larger juveniles (yearlings) using offshore areas more often. General juvenile salmonid use of the Action Area is expected to vary by species and life stage, as detailed below in the species-specific information.

5.1.1 Chinook Salmon

Chinook salmon (*Oncorhnchus tschawytscha*) mature between 2 and over 6 years of age (Myers et al. 1998). Fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991). Post-emergent fry seek shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers et al. 1998). Chinook salmon described in this BA typically exhibit an ocean-type life history, and smolts outmigrate predominantly as subyearlings, generally during April through July. Some Chinook salmon return from the ocean to spawn 1 or more years before full-sized adults return, and are referred to as jacks (males) and jills (females).

There is some evidence that subyearling Chinook hold in the Portland Harbor area over a longer period than other species of salmonids, attributed to their active feeding during migration (Knutsen and Ward 1991). Yearling Chinook may over-winter in the Lower Willamette River (NMFS 2002). ODFW (2005) observed that the median migration rate for yearling Chinook salmon during the study was 11.3 kilometers per day and median residence time in the study area was 3.4 days, and most tagged Chinook (76 percent) in the study were recovered in offshore, as opposed to nearshore, areas.

5.1.1.1 Upper Columbia River Chinook Salmon

The Upper Columbia River Spring Run ESU of Chinook salmon is listed as endangered by the ESA, and includes all naturally spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington (excluding the Okanogan River), the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to Chief Joseph Dam in Washington, as well as six artificial propagation programs: the Twisp River, Chewuch River, Methow Composite, Winthrop National Fish Hatchery (NFH), Chiwawa River, and White River spring-run Chinook hatchery programs.

Upper Columbia River Spring Run Chinook salmon have a stream-type life history; the juveniles typically spend 1 year in freshwater before migrating to the Pacific

Ocean (Myers et al. 1998). Most adults return after spending 2 years in the ocean, while 20 to 40 percent return after 3 years at sea. Peak spawning for all three populations occurs from August to September. Adult Upper Columbia River Spring Run Chinook salmon would be expected to be in the Columbia River portion of the Action Area during spawning migrations from March through May, with the peak moving through the action area in mid-April. Outmigrating juveniles likely move through the Columbia River portion of the Action Area from late April through early July, with the majority present in late May.

5.1.1.2 Snake River Spring/summer Chinook Salmon

The Snake River Spring/Summer Run ESU of Chinook salmon is listed as threatened by the ESA, and includes all natural-origin populations in the Tucannon, Grande Ronde, Imnaha, and Salmon Rivers. The present range of spawning and rearing habitat for naturally spawned Snake River Spring/Summer Run Chinook salmon is primarily limited to the Salmon, Grande Ronde, Imnaha, and Tucannon River subbasins.

Most Snake River Spring/Summer Run Chinook salmon enter their individual subbasins from May through September, and juvenile Snake River Spring/Summer Run Chinook salmon emerge from spawning gravels from February through June (Peery and Bjornn 1991). Typically, after rearing in their nursery streams for about 1 year, smolts begin migrating seaward in April and May (Bugert et al. 1990; Cannamela 1992). After reaching the mouth of the Columbia River, smolts inhabit nearshore areas en route to their Pacific Ocean residence, which lasts 2 to 3 years. The peak run of adult Snake River spring Chinook through the Columbia River portion of the Action Area occurs from early April to mid-May, and from late June to early July. This ESU tends to move downstream rapidly. Many juveniles in this ESU are transported by barge or truck around the Snake River and Columbia River dams and released downstream from Bonneville Dam. Juveniles would be expected in the Columbia River portion of the Action Area from mid-June to late September.

5.1.1.3 Snake River fall-run Chinook Salmon

The Snake River Fall Run ESU of Chinook salmon is listed as threatened by the ESA and includes all natural-origin populations of fall Chinook salmon in the mainstem Snake River and several tributaries including the Tucannon, Grande Ronde, Salmon, and Clearwater Rivers. Fall Chinook salmon from the Lyons Ferry Hatchery on the Snake River are included in the ESU, but are not listed.

Natural Snake River Fall Run Chinook salmon spawning occurs primarily in the Snake River below Hells Canyon Dam and the lower reaches of the Clearwater, Grand Ronde, Salmon, and Tucannon Rivers, but does not occur near the confluence of the Columbia River near the Park. Adult Snake River Fall Run Chinook salmon enter the Columbia River in July and migrate into the Snake River from August through October. Snake River Fall Run Chinook salmon generally spawn from October through November. Fry emerge from March through April, and downstream migration generally begins within several weeks of emergence (Becker 1970; Allen and Meekin 1973). Juveniles rear in backwaters and shallow water areas through mid-summer before smolting and migrating to the ocean—thus they exhibit an ocean-type juvenile history. Once in the ocean, they spend 1 to 4 years (usually 3 years) before beginning their spawning migration. Fall returns in the Snake River system are typically dominated by 4-year-old fish. Adult Snake River Fall Run Chinook salmon would be expected to be in the Columbia River portion of the Action Area in August through early October, with the peak moving through in early September. Juveniles would be expected in the Columbia River portion of the Action Area from late June to late September.

5.1.1.4 Lower Columbia River Chinook Salmon

The Lower Columbia River Chinook salmon ESU is currently listed as threatened under the ESA (Table 1). The ESU includes all naturally spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas

River. The Lower Columbia River ESU of Chinook salmon includes both the fall-run and spring-run stocks. The majority of fish migrating through the Action Area are fall-run.

The majority of Lower Columbia River Chinook salmon juveniles emigrate to the ocean as subyearlings, and there is some evidence that yearling migrants that do occur may be influenced by hatchery programs (Howell et al. 1985; Hymer et al. 1992; Myers et al. 1998; Olsen et al. 1994; Reimers and Loefell 1967; WDF et al. 1993). Adults return to tributaries in the Lower Columbia River at 3 and 4 years of age.

Migrating Lower Columbia River Chinook adults may be present in the Willamette or Columbia River portions of the Action Area starting in August and continuing through November, with peak migration occurring in September and October, and in November for "tule" Chinook (Kostow 1995; WDF et al. 1993). Juveniles in this ESU would be expected in the Willamette and Columbia River portions of the Action Area starting in March, continuing through July, with peaks occurring in April, May, and June.

5.1.1.5 Upper Willamette River Chinook Salmon

The Upper Willamette River Chinook salmon ESU is currently listed as threatened under the ESA by NMFS. This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries, above Willamette Falls, Oregon. Fall Chinook salmon above Willamette Falls were introduced and are not considered part of this ESU. Populations in this ESU have a life history that shares features of both the stream and ocean types of Chinook salmon.

Adult Upper Willamette River Chinook may occur in the Willamette River portion of the Action Area concurrent with their upriver migration beginning in March and ending in July, with the peak between late April and early June (NMFS 2004a). Smolts may pass through the Willamette River portion of the Action Area from

January through June, and from August through December, and some Upper Willamette River juveniles may over-winter in the Lower Willamette River.

5.1.2 Coho Salmon

Coho salmon (*Oncorhynchus kisutch*) typically mature at 3 years of age. Adult coho salmon typically enter rivers between September and February and spawning occurs from November to January (Hassler 1987), but occasionally as late as February or March (Weitkamp et al. 1995). Post-emergent fry move into shallow areas with vegetative or other cover, dispersing up- or downstream as they grow larger. In summer and during over-wintering, coho salmon fry prefer pools or other slower velocity areas such as alcoves, with woody debris or overhanging vegetation. Juveniles may rear in fresh water for up to 15 months then migrate to the ocean as smolts from March to June (Weitkamp et al. 1995). Coho salmon adults typically spend 2 years in the ocean before returning to their natal streams to spawn.

In a recent study, ODFW (2005) documented that the median migration rate for coho salmon in the Willamette River study area was 4.6 kilometers per day and median residence times in the study area were 8.7 days for coho salmon. In spring, coho salmon were found in higher abundance in areas with rock outcrops as compared to other habitats (ODFW 2005).

5.1.2.1 Lower Columbia River Coho Salmon

The Lower Columbia River ESU of coho is currently designated as threatened under the ESA. The ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side, including the Willamette River as far upriver as Willamette Falls. The Willamette River and its tributaries historically provided important spawning grounds for Columbia River basin coho salmon (Fulton 1970); however, most coho habitat in this area has been blocked by numerous tributary dams. Decline in the natural production of Lower Columbia River coho is primarily due to freshwater and estuarine habitat degradation and the ensuing problems related to artificial propagation and overharvest of the wild stocks as part of the hatchery-origin fishery (Johnson et al. 1991; Cramer and Cramer 1994). The majority of Lower Columbia River coho return to spawn in the Columbia River between early December and March (NMFS 1991). In the Clackamas River, a tributary to the Willamette River, adult Lower Columbia River coho occur in two peaks: September (early run) and in January/February (late/native run) (Weitkamp et al. 1995). ODFW (2005) found that juvenile coho salmon in the Willamette River were found near shore more often than other species (43 percent) and were found more often near beaches and away from riprap and artificial fill.

For these reasons, it is expected that adult and juvenile coho salmon are likely to be present in the Willamette River portion of the Action Area as follows: adults are expected to occur in the deep water areas in the vicinity of the river during these periods of their upstream spawning migration, and juveniles may occur in the shallow water portions of the river during outmigration between February and July, peaking in May and early June (Cramer and Cramer 1994; Port of Portland and EES 2004a).

5.1.3 Chum Salmon

Chum salmon (*Oncorhynchus keta*) mature between 3 and 6 years of age. Adult chum salmon typically return to spawn between October and December (Salo 1991). The newly emerged fry typically begin downstream migration immediately, but a very small number of chum fry may reside in freshwater until the end of summer. Fry entering saltwater typically assemble in small schools close to shore and then gradually move to deeper waters as they grow and migrate toward open ocean waters. Chum salmon adults typically spend 3 to 5 years in the ocean before returning to their natal streams to spawn.

5.1.3.1 Columbia River Chum Salmon

The Columbia River ESU of chum salmon is currently listed as threatened under the ESA by NMFS. This ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon.

The majority of Columbia River chum salmon from tributaries below Bonneville Dam spawn on the Washington side of the Columbia River; in the Portland vicinity, chum salmon have been reported to occur in October in the Sandy River (Salo 1991). Columbia River chum salmon do not spawn in the Willamette River or its tributaries. However, chum salmon may occur in both the Columbia River or the Willamette River portion of the Action Area because adult Columbia River chum salmon must pass the mouth of the Willamette River during their upstream migration from late September through December, and outmigrating chum salmon fry may move into the Lower Willamette River for short periods during incoming tides (NMFS 2004a; Johnson et al. 1997). Adults would be expected to use the deep water sections of the Action Area in the Willamette or Columbia Rivers and juveniles would be expected in the shallow water.

5.1.4 Steelhead

Steelhead (*Oncorhynchus mykiss*) occur in two forms: 1) the anadromous steelhead and 2) the resident rainbow trout. The life histories of anadromous steelhead vary considerably, and adult steelhead spawners are divided into two races depending on the time of year they enter freshwater: summer-run and winter-run. Winter-run steelhead enter the rivers between November and April, whereas summer-run steelhead begin their migration from May to November (Busby et al. 1996). Summer-run steelhead generally enter freshwater between June and September, and spawn the following spring. Winter-run fish enter the rivers from December to February and spawn shortly thereafter. Steelhead adults typically spend 1 to 5 years in the ocean before returning to their natal streams to spawn. Steelhead spawn in cool, clear, and well-oxygenated streams with small to large gravel and suitable flow in conditions typical of upper tributaries of rivers (USFWS 1983). In a recent study, ODFW (2005) observed that the median migration rate for steelhead juveniles was 12.5 kilometers per day and median residence time in the Willamette River study area was 2.5 days.

5.1.4.1 Snake River Basin Steelhead

The Snake River Basin DPS of steelhead is listed as threatened by the ESA, and includes all naturally spawned anadromous *O. mykiss* populations below natural and constructed impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, as well six artificial propagation programs: the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs.

Fish in this DPS are summer steelhead. They enter freshwater from June to October and spawn during the following March to May. Two groups are identified: A-run steelhead, which enter freshwater during June through August, and B-run steelhead, which enter freshwater during August through October. B-run steelhead typically are 75 to 100 millimeters longer at the same age (NMFS 2001). Both groups usually smolt as 2- or 3-year-olds. A-run populations would include at least the tributaries to the Lower Clearwater River, the Upper Salmon River and its tributaries, the Lower Salmon River and its tributaries, the Grand Ronde River, the Imnaha River, and possibly the Snake River's mainstem tributaries below Hells Canyon Dam. B-run populations would be identified in the Middle Fork and South Fork Salmon Rivers, the Lochsa and Selway Rivers (major tributaries of the upper Clearwater River), and the mainstem Clearwater River. These basins are, for the most part, large geographical areas and there probably is additional population structure within some of these basins. However, because that hypothesis has not been confirmed, NMFS assumes that there are at least five populations of A-run steelhead and five populations of B-run steelhead in the Snake River Basin steelhead DPS.

Adult Snake River Basin steelhead would be expected to be in the Columbia River portion of the Action Area from June to October, with the peak occurring in late June and early July. The downstream migration of juveniles occurs in the Columbia River portion of the Action Area from April through June.

5.1.4.2 Upper Columbia River Steelhead

The Upper Columbia River Basin DPS of steelhead is listed as threatened by the ESA. This DPS includes all naturally spawned populations below natural and constructed impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the United States/Canada border, as well six artificial propagation programs: the Wenatchee River, Wells Hatchery (in the Methow and Okanogan Rivers), Winthrop NFH, Omak Creek, and the Ringold steelhead hatchery programs.

As in other inland steelhead DPSs (Snake and Middle Columbia River), fish from the Upper Columbia steelhead DPS remain in freshwater up to 1 year before spawning. Smolt age is dominated by 2- and 3-year-olds; however, some of the oldest smolt ages for steelhead, up to 7 years, are reported for this DPS (Peven 1990). Based on limited data, steelhead from the Wenatchee and Entiat Basins return to freshwater after 1 year in saltwater, whereas Methow River steelhead typically spend 2 years in saltwater before returning (Howell et al. 1985). Similar to other inland Columbia River Basin steelhead DPSs, Upper Columbia River Basin steelhead adults typically return to the Columbia River between May and October and are considered summer-run steelhead. Adult Upper Columbia River steelhead would be expected to be in the Columbia River portion of the Action Area from late June through early November, with the peak occurring in late August to mid-September. Juveniles would be expected in the Columbia River portion of the Action Area during outmigration from mid-May through mid-June.

5.1.4.3 Middle Columbia River Steelhead

The Middle Columbia River Basin DPS of steelhead is listed as threatened by the ESA and includes all natural-origin populations in the Columbia River basin above the Wind River, Washington, and the Hood River, Oregon, including the Yakima River, Washington. Both the Deschutes River and Umatilla River hatchery stocks are included in the ESU, but are not listed.

This DPS includes summer- and winter-run steelhead. All steelhead upstream of The Dalles Dam are summer-run (Schreck et al. 1986; Reisenbichler et al. 1992; Chapman et al. 1994). The Klickitat River, however, produces both summer- and winter-run steelhead. Summer steelhead typically enter freshwater between May and October (Busby et al. 1996), migrate inland toward spawning areas, over-winter in the larger rivers, resume migration to natal streams in early spring, and then spawn (Meehan and Bjornn 1991). Winter steelhead typically enter freshwater between November and April in the Pacific Northwest (Nickelson et al. 1992), migrate to spawning areas, and then spawn in late winter or spring. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson et al. 1992). Most fish in this ESU smolt at 2 years and spend 1 to 2 years in saltwater before entering freshwater, where they may remain up to 1 year before spawning (Howell et al. 1985). Some adult summer or winter Middle Columbia River Basin steelhead could occur in the Columbia River portion of the Action Area from April through January while downstream migration occurs from late March through June, with peak abundance occurring from late April through mid-May.

5.1.4.4 Lower Columbia River Steelhead

The Lower Columbia River steelhead DPS is currently listed as threatened under the ESA. This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive) and the Willamette and Hood Rivers, Oregon (inclusive). Excluded are steelhead in the Upper Willamette River Basin above Willamette Falls and steelhead from the Little and Big White Salmon Rivers in Washington. This DPS includes both winter and summer runs of steelhead.

Summer- and winter-run Lower Columbia River steelhead adults may occur in the Willamette River portion of the Action Area all year, but peak juvenile outmigration occurs from late April through May (Busby et al. 1996; NMFS 2002). Use of the Willamette River portion of the Action Area by Lower Columbia River smolts is expected to be limited as they are generally expected to pass through this part of the Area in less than 1 day on their way seaward (NMFS 2002).

5.1.4.5 Upper Willamette River Steelhead

The Upper Willamette River steelhead DPS is currently listed as threatened under the ESA by NMFS. This DPS includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River, inclusive. Native Upper Willamette River steelhead of this basin are late-migrating winter-run, entering freshwater primarily in March and April (Oregon DEQ and USEPA 2002; Howell et al. 1985), whereas most other populations of west coast winter steelhead enter fresh water beginning in November or December.

Adult Upper Willamette River steelhead may occur in deeper waters of the Willamette River portion of the Action Area from January through mid-May (NMFS 2004a). Smolts may occur in shallow water areas from March through mid-July, with peaks occurring in May (NMFS 2002). There is no steelhead spawning in the Action Area. Use of the Willamette River portion of the Action Area by Upper Willamette River smolts is expected to be limited, as juvenile steelhead have been observed to quickly migrate through the Portland Harbor area, spending less time in the area than other juvenile salmonids (Knutsen and Ward 1991; NMFS 2002).

5.1.5 Sockeye

5.1.5.1 Snake River Sockeye

The Snake River ESU of sockeye salmon (*Oncorhynchus nerka)* is listed as endangered by the ESA and includes populations of sockeye salmon from the Snake River Basin, Idaho (extant populations occur only in the Salmon River subbasin). The progeny of fish from a listed population that are propagated artificially are considered part of the ESA-listed species and are protected under ESA.

Snake River sockeye salmon adults enter the Columbia River primarily during June and July. Spawning near Redfish Lake, which now supports the only remaining run of Snake River sockeye salmon, occurs primarily in October (Bjornn et al. 1968). Fry emerge from April through May, move immediately into the lake, and rear for 1 to 3 years before they migrate to the ocean (Bell 1986). Migrants leave Redfish Lake during late April through May (Bjornn et al. 1968), migrating through the Action Area toward the Pacific Ocean. Snake River sockeye spend 2 to 3 years in the Pacific Ocean and return in their fourth or fifth year of life. Adult Snake River sockeye could occur in the Columbia River portion of the Action Area starting in late May and continuing through early August, with the peak migrating during June and early July. Smolts would be expected in the Columbia River portion of the Action Area from late April to early July, with the peak in late May.

5.1.6 Bull Trout

5.1.6.1 Columbia River Bull Trout

The USFWS has listed the bull trout (*Salvelinus confluentus*) as threatened within the contiguous United States. This includes the Columbia River ESU, which may be found within the Willamette or Columbia River portions of the Action Area. Bull trout prefer the upper reaches of cold, clear running streams with clean gravel and cobble substrate for spawning.

Bull trout are not known to spawn within the Action Area. Juvenile and adult bull trout could be present in the Action Area at any time, but are more likely to be larger in size in the project area than juvenile salmon because few bull trout spawning areas occur near the project. Bull trout would have migrated over long distances before reaching the project area. Adult bull trout, similar to adult salmon, are expected to pass through the Columbia River portion of the project area quickly during upstream migration.

5.2 Pacific Salmonids Critical Habitat

Critical habitat is defined under Section 3(5)(A) of the ESA as: "the specific areas within the geographical area occupied by the species, at the time it is listed on which are found those physical or biological features that are essential to the conservation of the species and which require special management consideration or protection; and specific areas outside the geographical area occupied by the species at the time it is listed…upon determination by the Secretary that such areas are essential for the conservation of the species." Once critical habitat is designated, Section 7 of the ESA requires federal agencies to ensure they do not fund, authorize, or carry out any action that will destroy or adversely modify that habitat. This requirement is in addition to the Section 7 requirement that federal agencies ensure their actions do not jeopardize the continued existence of listed species.

The Action Area is within designated critical habitat for each of the ESUs and DPSs discussed in this BA, except the Lower Columbia River ESU of coho salmon and Columbia River bull trout. For the Lower Columbia River coho salmon ESU, critical habitat has not been proposed or designated. For the Columbia River bull trout ESU, critical habitat was designated for the Klamath River and Columbia River populations of bull trout on September 21, 2004. However, the mainstem Columbia River has been excluded from critical habitat under Section 4(b)(2) in support of multiple management actions being undertaken in these reaches through the Federal Columbia Power System (Fed Reg 69, 59999).

Affected ESUs and DPSs include Upper Columbia River Chinook salmon, Snake River spring/summer Chinook salmon, Snake River fall-run Chinook salmon, Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum, Snake River Basin steelhead, Upper Columbia River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, and Snake River sockeye. Critical habitat for these species includes the stream channels within the proposed stream reaches, and includes a lateral extent as defined by the ordinary high water mark (OHWM) (33 CFR 319.11).

Regarding these species, NMFS reviews the status of critical habitat affected by the proposed action by examining the condition and trends of primary constituent elements (PCEs) throughout the designated area. PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents identifying critical habitat. The salmonid ESUs and DPSs considered in this BA share many of the same river reaches and have similar life history characteristics and requirements (and share the same PCEs). The PCEs potentially found in the Action Area include freshwater rearing and freshwater migration during the juvenile stage of the salmonid life cycle (Table 4).

Table 4
Sites and Essential Physical and Biological Features Designated as PCEs, and the Species Life Stage Each PCE Supports[1]

Site	Essential Physical and Biological Features	ESU Life Stage
Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover[2]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover	Juvenile and adult mobility and survival

1 – This table adapted from NMFS 2005a.

2 – Shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

The condition of critical habitat PCEs in the Action Area for salmonids is limited by several factors: temperature of the Lower Willamette River in summer, the lack of floodplain connectivity, lack of shallow water habitat, altered hydrology, lack of complex habitat to provide forage and cover, and the presence of overwater structures. There will be no losses of critical habitat as part of this project.

Critical habitat in the Action Area includes the aquatic areas affected by the Removal Action extending landward to the OHWM. Based on a historical analysis of U.S. Geological Survey (USGS) water level data from 1972 to 2004, water levels in the Action Area typically reach the OHWM less than 1 percent of the time from February to May, which overlaps the period that juvenile salmonids would be expected to be in the Action Area (Anchor 2006a).

6 ENVIRONMENTAL BASELINE

This section describes the existing conditions in the Action Area, which includes the effects of past and ongoing human and natural factors leading to the current status of the species, their habitat, and ecosystems. In general, physical habitat conditions in the Action Area and vicinity are degraded for many habitat elements considered for listed species. The Willamette River portion of the Action Area lies within a highly active area of the Portland Harbor and Portland metropolitan area, and is within the Industrial Sanctuary designated by the City of Portland's Comprehensive Plan. As a result, physical development (e.g., shoreline modification, dredging) and high disturbance (e.g., vessel traffic, ship wakes) that would be expected for these areas are present. The Columbia River portion of the Action Area is likewise typically industrialized and is active with vessel traffic. The following sections provide more detail on the characteristics of existing Action Area habitat conditions. Because the majority of work that may affect listed species will occur in the Willamette River portion of the Action Area, general information is given below on the Columbia River portion of the Action Area, and detailed information is provided for the Willamette River.

6.1 General Information on the Columbia River Portion of the Action Area

The Columbia River is approximately 1,210 miles long and drains a watershed area of approximately 260,000 square miles. This portion of the river has been affected by the development and operation of the Federal Columbia River Power System (FCRPS) dams. These dams have eliminated spawning and rearing habitat and have altered the natural hydrograph of the Snake and Columbia Rivers, decreasing spring and summer flows and increasing fall and winter flows. The dams also alter smolt and adult migrations, as well as create habitat for predators.

6.2 Biological Communities in the Willamette River

Compared to pre-European settlement, the general health of aquatic biota of the Lower Willamette River has been adversely affected by anthropogenic stresses including loss of habitat due to physical alterations, chemical impacts, and biological stresses from introduction of exotic species. Extirpations of sensitive species have occurred, and introductions of non-native species have resulted in increased competition for food and habitat for native species.

The existing fish community in the Lower Willamette River consists of warm-water, cool-water, and cold-water fish. There are several listed salmonid ESUs that may occur in the Action Area, as well as at least 33 other native and introduced species of both warm-water and cool-water fish that have been identified in the Lower Willamette River (ODFW 1994). These fish include white sturgeon, northern pikeminnow, smallmouth bass, peamouth chub, reticulated and prickly sculpin, common carp, largescale sucker, Pacific lamprey, threespine stickleback, pacific sculpin, yellow perch, American shad, grass carp, warmouth, and western mosquitofish (Farr and Ward 1993; EES 2003).

Previous BAs prepared for activities in Terminal 4 Slip 3 (Port of Portland and EES 2004a and 2004b) describe several benthic macroinvertebrates and zooplankton known to be present in the Lower Willamette River, listing oligochaetes, mysid shrimp, the amphipod *Corophium salmonis*, chironomid (midge) larvae, crayfish, mollusks, several species of cladocera, copepods, hydracarina (water mites), and mayflies.

6.3 Aquatic Habitat in the Willamette River

This section describes aquatic habitat characteristics typically considered for documenting environmental baseline conditions for Pacific salmonids. These characteristics that are suited to the type of habitat provided within the Action Area include adult migration and juvenile rearing habitat. No salmonid spawning habitat occurs within the Action Area.

Historically, floodplains, off-channel, and shallow water habitats existed in the Portland area, with large off-channel lakes such as Lake Guilds, Lake Doane, and Lake Ramsey (WRI 2004). In the last 150 years, the Lower Willamette River channel has deepened, narrowed, and simplified; banks have been hardened and lined (WRI 2004); floodplain, off-channel, and shallow water habitats have been filled; and banks have been steepened. Currently, the majority of the mainstem Willamette River channel, including mainstem areas bordering Terminal 4, is characterized by deep (greater than 20 feet NGVD 29) open-water areas in the navigation channel and relatively narrow strips of shallower areas (less than 20 feet NGVD 29) adjacent to shorelines. The shorelines are frequently broken by areas with seawalls or other structures that lack shallow water habitat.

As part of the Clean Water Act (CWA) 404(b)(1) analysis, the habitat in the Removal Action Area was characterized based on physical features of the shoreline and riverbanks, as well as water depth. Table 5 summarizes the results of that characterization.

Table 5
Characteristics of Aquatic Habitat in the Removal Action Area

Habitat Characteristic	Slip 3	Wheeler Bay	North of Berth 414	Total
Less than 20 feet water depth (acres)	1.7	4.0	0.8	6.5
Greater than 20 feet water depth (acres)	11.7	1.2	1.4	14.3
Less than 20 feet water depth, less than 20 percent slope (acres)	0	3.2	0	3.2
Inundated pilings (acres)	3.0	0.0	0.0	3.0
Overhead pier structures (acres)	1.8	0	0	1.8
Total shoreline length (feet)	1,875	1,120	775	3,770
Bank Type[1]				
Structures length (feet)	1,523		696	2,219
Unclassified fill (feet)	352	766		1,118
Seawall (feet)			79	79
Riprap (feet)		354		354

1 – Bank Types as Classified by City of Portland (2001).

6.3.1 Surface Sediment Quality at Terminal 4

The *Site Characterization Report* (BBL 2004b) evaluated surface sediment concentrations in the Removal Action Area and confirmed the degraded condition of sediment quality in the vicinity of Terminal 4. The EE/CA indicated that existing surface sediment contaminants have likely impacted wildlife by direct or indirect exposure due to direct contact, feeding, or bioaccumulation (BBL 2005).

In the *Site Characterization Report*, sediments were evaluated against two sediment quality guidelines: Threshold Effects Concentrations (TECs) and PECs. The TEC is a low effects guideline that represents concentrations below which toxicity effects are unlikely to be observed in freshwater benthic invertebrates. The PEC is a higher, probable effects guideline that represents concentrations above which toxicity effects are likely to be observed in freshwater benthic invertebrates. Dividing the chemical concentration by the PEC or TEC results in an exceedance ratio, which if greater than 1, indicates a concentration greater than the guideline. Additional details on TEC and PEC data collected in the Removal Action Area are available in the *Site Characterization Report*, but some information on the PEC, as the higher guideline, is presented here; for reference, the following PEC exceedances were reported in the *Site Characterization Report*:

- Lead in two samples and zinc in one sample of Slip 3 surface sediment. The lead PEC exceedance ratios were 2 and 5, and the zinc PEC exceedance ratio was less than 2.
- Some PAHs in some samples of Slip 3 surface sediment. The maximum PEC exceedance ratio for total PAHs was 26.
- Lead in one Wheeler Bay surface sediment sample. The PEC exceedance ratio was less than 2.
- Some PAHs in one sample of Wheeler Bay surface sediment. The PEC exceedance ratio for total PAHs in that sample was less than 2.

Sediments within the Berth 411 dredging area were historically contaminated with pencil pitch, ores, diesel, and other hydrocarbons. Thus, chemical testing to characterize sediments at Berths 411 has been conducted as part of a number of recent investigations, the most recent of which occurred in 2007 (Early Action Sheetpile Wall Sampling [no report yet]), which sampled locations within the proposed dredge prism at the berths. Based on subsurface samples from this sampling in the Berth 411 dredging area, the PEC was exceeded for lead (up to 8.5 times the exceedence ratio), pyrene (up to 3.3 times PEC), benzo(a)anthracene (up to 8.4 times PEC), and benzofluoranthene (up to 1.8 times PEC).

Another prior sampling event by Hart Crowser (2002) indicated that surface sediment in the vicinity of Berth 410 exceeded Screening Levels (SLs) for PAHs, and surface sediment from Berth 411 area exceeded dredged material maximum levels (MLs) for PAHs, as well as SLs for metals and a few miscellaneous organics (Hart Crowser 2002). Subsurface sediment from this sampling indicated that SLs were exceeded at some depths for cadmium, lead, zinc, polychlorinated biphenyls (PCBs), and DDT, and MLs were exceeded for PAHs (Hart Crowser 2002). Also, in 2006, an AMEC study found that zinc concentrations slightly exceeded the SL (AMEC 2006). Additional sediment quality information is presented in Section 3.2.2 for the Berth 410 dredging area.

6.3.2 Water Quality

Water quality in the Willamette River is regulated by the State of Oregon and enforced by the Oregon DEQ, with both numeric and narrative standards designed to protect designated beneficial uses. According to these standards, the Willamette River, from its mouth at the Columbia River to Willamette Falls, exhibits the following designated beneficial uses: Public Domestic Water Supply, Private Domestic Water Supply, Industrial Water Supply, Irrigation, Livestock Watering, Fish and Aquatic Life, Wildlife and Hunting, Fishing, Boating, Water Contact Recreation, Aesthetic Quality, Hydro Power, and Commercial Navigation and Transportation.[3]

The sections below describe existing conditions at Terminal 4 for various water quality parameters.

6.3.2.1 Dissolved Oxygen

DO in the Lower Willamette is not listed on Oregon DEQ's 303(d) list as a parameter of concern. In data collected between 1990 and 2001 in support of the Portland Harbor RI/FS Programmatic Work Plan, DO at the Spokane, Portland, and Seattle (SP&S) railroad bridge (RM 7; approximately 2.3 miles from Terminal 4) ranged from 6.4 to 14.2 milligrams per liter (mg/L) throughout the year (LWG 2004). Data collected in October and November of 2000 during ODFW's fish use study of the Lower Willamette River indicated that DO readings in the vicinity of Terminal 4 ranged from 10.9 to 11.2 mg/L during this period.

[3] OAR 340-041-0340, Table 340A

6.3.2.2 pH

Oregon DEQ's 303(d) list does not list pH in the Lower Willamette as a parameter of concern. Data collected in 1990 and 2001 to support the Portland Harbor RI/FS Programmatic Work Plan indicated that pH at the SP&S railroad bridge (RM 7) ranged from 6.8 to 8.3 throughout the year (LWG 2004).

6.3.2.3 Temperature

Oregon DEQ and USEPA have developed and approved new water quality standards for Oregon waters (Port of Portland and EES 2004a). The basis for the new Oregon DEQ temperature standard for the Lower Willamette River was the protection of cold-water species such as anadromous salmonids. The portion of the Willamette River that includes Terminal 4 is identified by the Oregon DEQ as providing migration habitat for salmon and steelhead. The temperature standard set for this area includes the stipulations that the 7-day-average maximum temperature may not exceed 68.0° F (20.0° C), and the waterbody must have cold-water refugia that is significantly distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the waterbody (OAR 340-041-0028(4)).

The Lower Willamette River (RMs 0 to 24.8) is on the Oregon 303(d) list as water quality limited for temperature during the summer months (Oregon DEQ 2003). The listing for the Willamette River was based on data collected by the Oregon DEQ at RMs 7.0 and 13.2 between water years 1986 and 1995 (Oregon DEQ 2003), wherein the temperature water column criterion was 68° F (20° C) and summer data from these years (except 1991) showed that 68 percent (34 of 50) of the samples recorded at RM 7.0 exceeded the temperature standard (the maximum recorded was 26° C in July 1988).

More recent temperature data, collected by the Oregon DEQ laboratory (Oregon DEQ 2004) at the SP&S railroad bridge (RM 7.0) were reviewed by the Port of Portland and EES (2004a) for the time-period 1994 to 2004. They found that data were consistent with historic data, indicating that mid-summer temperatures continued to exceed the temperature standard.

6.3.2.4 Sediment/Turbidity

Average turbidity levels in the Lower Willamette River fluctuate throughout the year, but tend to be greater in fall and winter. Oregon DEQ (2004) collected turbidity information in the vicinity of the SP&S railroad bridge at RM 7.0, 2.3 miles from Terminal 4. Average monthly turbidity in the months of December, January, and February (1995 to 2000) was 16, 39, and 47 nephelometric turbidity units (NTUs), respectively; maximum ambient turbidity levels were 24, 46, and 149 NTUs, respectively. Turbidity levels in this study were generally much lower during the summer and early autumn with average monthly turbidity ranging between 4 and 8 NTUs for the months of July through October; maximum turbidity levels during these months ranged from 4 to 18 NTUs.

Additional turbidity data in the vicinity of the Action Area were collected as part of the Removal Action Area characterization in Slip 3 over three periods between March 18 and May 17, 2004 (BBL 2004b), with typical turbidity of 6 NTUs with turbidity spikes ranging between 40 and 300 NTUs. Average turbidity at the inner portion of Slip 3 East ranged between 7.5 and 9 NTUs, while average values recorded at the outer portion of Slip 3 were 9, 15, and 23 NTUs for the months of March, April, and May, respectively.

Ongoing river-induced sedimentation of suspended sediments occurs nearly continuously throughout the Action Area (BBL 2004b), and the periodic redistribution of this material affects long-term sediment accumulation patterns within the slips adjacent to the Action Area. In addition, the Willamette River experiences periodic high turbidity during flood events. Although historically the Willamette River may have had high periodic turbidity levels, the channelization of the Lower Willamette River has resulted in most of the sediment from high flows now discharging directly into the Columbia River.

As characterized under low-flow, low-rainfall conditions, the hydraulics and sedimentation in the Removal Action Area have the following attributes (BBL 2004b):

- Hydraulics within Slip 3 are affected by variations in river flow, stage, ship-induced currents, and to a lesser extent, localized currents from stormwater discharge.
- River induced currents in the slips are low in velocity compared to river velocity.
- Current velocities in a majority of the Removal Action Area are dominated by propeller-induced currents, which result in increased circulation, velocities, and turbidity levels that extend beyond the paths that ships take in Slip 3. These currents also influence sediment transport in the Removal Action Project Area.
- Ongoing river-induced sedimentation of suspended sediments occurs nearly continuously throughout the Removal Action Area and periodic redistribution of this material affects long-term sediment accumulation patterns within the slips.

6.3.2.5 Chemical Contamination/Nutrients

Water quality data collected as part of the RI for Slip 3 (Hart Crowser 2000) indicated that metals, HPAHs, and phthalates were detected at three sampling locations, but concentrations did not exceed ambient water quality criteria in any of the samples. Table 6 provides a list and status of chemical contaminants and bacteria on Oregon DEQ's 303(d) list because of impairment of one or more designated beneficial uses of water in the Lower Willamette River. These contaminants include mercury, fecal coliform, PAHs, iron, manganese, pentachlorophenol, and pesticides.

Table 6
Chemical Contaminants and Bacteria Information from Oregon DEQ 303(d) List in the Lower Willamette River, From RM 0 to RM 24.8

Parameter	Standard/Criteria	Season	Supporting Data
PCB	Fish tissue	Year-round	Oregon Health Division fish advisory issued November 21, 2001.
Mercury	Fish tissue	Year-round	Mercury concentrations have exceeded the criteria for fish tissue (0.35 pm) based on data collected since 1969. A public health advisory was issued for the consumption of fish tissue.
Fecal Coliform Bacteria	Water column geometric mean of 200, no more than 10% of samples >400	Year-round	Oregon DEQ data show that 39% (20 of 51) of samples at RM 7.0 and 31% (20 of 65) of samples (fall, winter, spring) at RM 13.2 exceed fecal coliform standard, between water years 1986 to 1995.
PAH	Water column criterion = 2,800 pg/L	Year-round	USGS site at RM 6: 35 day average concentration of 52,900 pg/L.
Iron	Water column criterion = 300 µg/L	Year-round	Oregon DEQ data at RM 6.9 show that two of four samples exceed criterion.
Manganese	Water column criterion = 50 µg/L	Year-round	Oregon DEQ data at RM 13.1 show that two of five samples exceed criterion.
Pentachlorophenol	Sediment criterion = 1.01 mg	Year-round	Oregon Health Division alert regarding fishing and swimming in the area of McCormick and Baxter due to soils and sediment contaminated by creosote.
Pesticides (Dieldrin, Aldrin, DDE/DDT)	Fish tissue	Year-round	Oregon Health Division fish advisory issued November 20, 2001.
DDT	Water column	Year-round	USGS data at RM 12.7 show that two of nine samples exceeded the criterion of 0.000024 µg/L.

Source: Port of Portland and EES 2004b
µg/L = micrograms per liter
pg/L = picograms per liter
mg = milligrams

6.3.3 Habitat Access

6.3.3.1 Physical Barriers

There are no physical barriers to migration of adult or juvenile salmon in the Action Area. However, in the Willamette River, there is one mainstem dam at Willamette Falls and 13 tributary dams that largely regulate flows and present barriers to salmonid migration, despite fish passage facilities at some of these locations (Port of Portland and EES 2004a). Other physical barriers on Willamette River tributaries include undersized culverts and other developments that block access to historically available habitat (Foster 1991).

6.3.4 Habitat Elements

6.3.4.1 Substrate

Benthic habitats in the Action Area can be generally divided into three types: 1) unconsolidated sediments (sands and silts) in the deeper water and lower channel slopes; 2) unconsolidated sediments (sands and silts) in shallower areas; and 3) developed underwater structures such as rock riprap, sheetpile, and bulkheads. The deeper habitat with typically unconsolidated sediment tends to be in the center of Slip 3 and the outer portions of Wheeler Bay. Shallow water areas are found at the margins of the slips and Wheeler Bay and under docks and piers. Most of the shallow areas also contain concrete and wooden piling, riprap, and other debris.

Grain sizes in parts of the Action Area have been characterized as follows (BBL 2004a; Hart Crowser 2000):

- Wheeler Bay: sandy clayey silt
- North of Berth 414: various mixtures of sand, clay, and silt
- Slip 3: silty sands and clayey silts

6.3.4.2 Large Woody Debris

No comprehensive survey data of LWD frequency has been conducted for the Lower Willamette River or in the vicinity of the Action Area (Port of Portland and EES 2004a). However, LWD recruitment potential in the Action Area is low due to removal of riparian vegetation, river channelization, and the river's reduced floodplain access. The shoreline of the Action Area is characterized primarily by industrial facilities, docks, and remnant piling.

6.3.4.3 Shallow Water Habitat

Shallow water salmonid habitat in the Lower Willamette River has been reduced and degraded (primarily steep-sloped riprap shoreline) due to channelization, diking, dredging, and filling. High quality shallow water habitat typically exhibits gently sloped shoreline with fine-grained substrate and in-water and overwater cover.

6.3.4.4 Off-channel Habitat

Off-channel salmonid habitat in the Lower Willamette River has been reduced and degraded due to channelization, diking, dredging, and filling. High quality off-channel habitat typically exhibits riparian cover and reduced velocities relative to the main channel; this habitat is lacking in the Action Area.

6.3.4.5 Refugia

Refugia habitat (e.g., thermal refuge, velocity refuge, and high quality holding and rearing habitat) has been degraded or lost in the Lower Willamette River. In the Action Area, habitat has been significantly altered by industrial development and high quality refugia is lacking. However, current velocity in slip areas is lower than in the mainstem river during higher flow events.

6.3.5 Channel Conditions and Dynamics

6.3.5.1 Streambank Condition

Most of the banks in the Action Area typically contain piling, sheetpile, riprap, vertical cement walls, metal debris, and docking facilities. As noted in Table 3, of the 3,770 linear feet of bank habitat in the Removal Action Area, 2,219 feet are bordered by an overwater pier structure, 79 feet are armored by seawalls, and 354 feet contain riprap armor material. Riparian vegetation in the Action Area is sparse and limited, consisting chiefly of immature black cottonwood, with a few Oregon white ash, red alder, and willow. This vegetation exists in the areas of Slip 1 and along the east side of Slip 3, and mostly occurs among shoreline debris and piling.

Bank erosion west of Berth 409 and Slip 1 and in Wheeler Bay has been recognized as a historical and potential ongoing source of localized sediment contamination to the Action Area (BBL 2005; Ash Creek/NewFields 2007). As discussed in Section 3.4, the Wheeler Bay shoreline in particular is highly degraded due to its oversteepened banks and potential for contamination. Most of the riverbank soil in the Wheeler

Bay area contains several substances that exceed screening criteria. Wheeler Bay soil is not stabilized against erosion, and source control measures of the riverbank soil have been recommended (Ash Creek/NewFields 2007).

6.3.5.2 Floodplain Connectivity

Floodplain connectivity has been lost or reduced in the Action Area and in the vicinity of the Lower Willamette River due to flood control projects, dams, and urbanization.

6.3.6 Flow/Hydrology

6.3.6.1 Peak/Base Flows

Patterns of flow in the vicinity of the Action Area have been altered by water management projects and dams that have minimized rapid periodic increases in peak flow, which would have previously been typical to the Willamette River. Annual minimum flows in the vicinity of the Action Area typically occur in August, and rapidly increase from October to December, peaking in December and January (NMFS 2004a).

6.3.6.2 Drainage Network

The Action Area within the Lower Willamette Basin exhibits an anthropogenic drainage network that conveys runoff from developments and roadways.

6.3.7 Watershed Conditions

6.3.7.1 Road Density and Location

Road density in the vicinity of the Action Area is high due to the high population densities and developments.

6.3.7.2 Disturbance History

The Lower Willamette River channel morphology, streambanks, and floodplain areas have been substantially modified by development and urbanization within the channel, floodplains, and adjacent areas. Habitat connectivity has been lost both longitudinally along the river and laterally from the vegetated riverbanks to the upland forests (City of Portland 2004).

6.3.7.3 Riparian Reserves

Riparian vegetation in the Lower Willamette River is limited, and riparian functions, such as shade, organic inputs, and recruitment of LWD, have been reduced or do not occur.

6.4 Summary of Existing Conditions in the Action Area

In summary, habitat in the vicinity of the Action Area currently exhibits degraded habitat conditions in many of the characteristics discussed above. The shoreline of Terminal 4, in particular, contains many of the abundant anthropogenic structures and facilities typical of the surrounding area in the Willamette River. The context of the entire Action Area within the larger landscape (in the Columbia River as well as the Willamette River) is a highly developed zone within an industrial area with a long history and legacy of anthropogenic activities.

7 EFFECTS OF THE PROPOSED ACTION AND EFFECTS DETERMINATIONS

In Sections 5 and 6 of this document, the biological requirements of listed species and the environmental baseline of habitat in the Action Area were defined. This section addresses direct, indirect, interrelated, interdependent, and cumulative effects of the proposed action on listed species and designated critical habitat. Potential direct effects are those effects that occur at or very close to the time of the action. Indirect effects are those that are caused by the proposed action and occur later in time, but still are reasonably certain to occur. Interrelated effects are those that are associated with a larger action and depend on the larger action for their justification. Interdependent effects are those with no independent utility apart from the proposed action. Cumulative impacts are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the Action Area of the proposed project subject to consultation.

Although some individual organisms may experience adverse effects, the proposed project will provide long-term benefits for listed species by removing contamination in the Removal Action Area. The overall impact of the completed project on listed species and habitats is anticipated to be a net long-term benefit.

7.1 Pacific Salmonids

7.1.1 Project Effects

7.1.1.1 Direct and Indirect Effects

Potential direct and indirect effects on Pacific salmonids assessed for this project incorporate those resulting from disturbance to food sources, entrainment, water quality impacts, and alteration of nearshore habitat.

7.1.1.1.1 Food Source

Dredging and capping will temporarily disturb existing benthic organisms and habitat. However, as described in Section 6 of this BA, the substrate in most shallow areas of Terminal 4 is highly modified and exhibits an abundance of overwater structures, concrete and wooden piling, riprap, and other debris, resulting in less area for production of epibenthic salmonid prey on bottom substrates in shallow water in these locations. Also, there is some evidence that juvenile Chinook and coho diets may more be tied to pelagic food webs rather than epibenthic prey items (ODFW 2005). Thus, while disturbances to benthic habitat will occur during project activities, due to existing compromised habitat (for all salmonids) and diet preferences (for Chinook), it is expected that impacts to juvenile salmonids via disturbance of the epibenthic prey community will be minimal.

Direct impacts to pelagic invertebrate species could result during dredging activities as a result of short-term increases in turbidity, decreases in DO, and resuspension of contaminants that may occur as a result of the project. Studies on *Daphnia spp.* reveal that there is evidence for photo-induced adverse effects of PAHs, but results have varied. In one study, *Daphnia* were documented to biotransform 50 percent of some accumulated PAHs in between 0.4 and 0.5 hours (Southworth et al. 1978); another study showed daphnids accomplished a 21 percent loss of benzo(a)pyrene in 18 hours. Whitman and Miller (1982) found that naphthalene completely inhibited the phototactic response of *D. magna* at 2.0 mg/L and depressed the response at 1.0 mg/L. Further, *Daphnia* spp. are expected throughout the water column in many areas of the project vicinity, and impacts resulting from exposure to contaminants are not expected to be at a level that would affect the abundance of these ubiquitous prey items.

For these reasons, it is anticipated that any impacts to the prey community as a result of the proposed action will have little effect on salmonids. Moreover, the purpose of conducting the removal of sediment contamination in the Action Area is to reduce exposure to existing contaminants and to provide long-term benefits to prey species, as well as salmonids, by significantly improving overall benthic habitat conditions at Terminal 4.

7.1.1.1.2 Entrainment

Dredging operations are not expected to entrain juvenile salmonids. Pressure waves created as the bucket descends through the water column will forewarn salmonids present within the area and will allow individuals time to avoid the mechanism. In addition, the clamshell jaws will be open during descent, which should reduce the likelihood of entrapping or containing fish (NMFS 2003). The U.S. Army Corps of Engineers (Corps) conducted extensive sampling within the Columbia River in 1985 through 1988 (Larson and Moehl 1990). In the study, no juvenile salmon were entrained. McGraw and Armstrong (1990) examined fish entrainment rates outside of peak migration times in Grays Harbor from 1978 to 1989 and found that one juvenile salmon was entrained.

7.1.1.1.3 Water Quality

Potential short-term water quality impacts will occur as a result of construction during Phase I of the Removal Action. Conservation measures (Section 3.2.4) and water quality monitoring will be applied for these events. The Port will be in active communication with USEPA to ensure close coordination in the event of exceedances.

The following actions will be conducted that will minimize short-term water quality effects on fish:

- All dredged sediments will be removed to an upland disposal location and any new cover or capping materials will be clean, which will have the long-term effect of sustaining a healthier invertebrate community and improve foraging opportunities for salmonids.
- Water quality in the Action Area and at the offloading location will be monitored during dredging and offloading, and additional actions will be taken to reduce short-term water quality impacts, if unacceptable water quality is observed (Section 3.2.4).

Water quality elements and potential effects are discussed in detail below.

Dissolved Oxygen

During dredging, suspension of anoxic sediment compounds may result in reduced DO in the water column as the sediments oxidize, but any reduction in

DO beyond background is expected to be limited in extent and temporary in nature. Based on a review of four studies on the effects of dredging on DO levels, LaSalle (1988) showed little or no measurable reduction in DO around dredging operations[4]. In addition, impacts to listed fish due to any potential DO depletion around dredging activities is expected to be minimal for several reasons: 1) the relatively low levels of suspended material generated by dredging operations; 2) counterbalancing factors in the area, such as tidal or current flushing; 3) DO depletion typically occurs low in the water column; and 4) high sediment biological oxygen demand created by suspended sediment in the water column is not common (LaSalle 1988; Simenstad 1988). A reduction in DO during the dredging activities at Terminal 4 is expected to be minimal as the carbon content (surrogate for biological oxygen demand) is low—approximately 0.8 percent (BBL 2005).

During capping or placement of the sand layer at the Head of Slip 3, material placed is not expected to result in a change in sediment oxygen demand (and resulting DO reduction) during transport through the water column. There may be minor resuspension at the point of impact of the placed materials; however, this condition is expected to be temporary and localized, and the activity will be monitored by water quality testing. Based on the above information, during dredging and material placement, DO is not expected to drop to a level that will detrimentally impact salmonids that may occur in the area.

Exposure to Contaminants

The primary goal of the Removal Action is to reduce the potential exposure of aquatic organisms to chemical contaminants in the sediments. As such, physical disruption of the contaminated sediments during dredging is necessary to implement the Removal Action. This dredging action could cause a short-term increase in concentration of some chemicals in the water column in the

[4] Bucket dredge operation in channel in New York; cutterhead dredge operation in Grays Harbor, Washington; hopper dredge operation in Oregon tidal slough; bucket dredging operation in widened portion of lower Hudson River, New York.

immediate vicinity of the dredging as a result of resuspension of sediment or desorption of the contaminants from the sediment particles. If present in the water near the dredge action, juvenile salmonids could experience increased exposure to contaminants, and if this condition persists over a long period of time, exposure could present a risk of increased bioaccumulative chemicals in tissue. However, suspended sediment increases that may occur during dredging are expected to be short-term and localized.

Dredge elutriate testing (DRET), which simulates the release of contaminants into the water column caused by sediment resuspension at the point of dredging (USACE 2003), was completed for sediment in the Removal Action Area. Results indicated that little or no short-term water quality effects are predicted for toxic constituents, as dissolved chemical constituents in DRET samples were either undetected, below water quality criteria, or comparable to ambient background levels (BBL 2005).

The timeline for the potential for exposure related to dredging the Berth 411 Plus and Berth 410 areas is expected to occur intermittently during the approximately 3 to 4 weeks of the in-water work window during construction. The in-water work window was identified by NMFS because very few juvenile salmon are expected to be in the vicinity of Terminal 4 (or in the Lower Willamette River), and any salmonids present would be expected to move through the Terminal 4 area relatively quickly and are unlikely to remain in the vicinity for longer than one day[5].

The DRET test results, combined with the timing of in-water work to coincide with the NMFS in-water work window, suggest a minimal chance of listed fish experiencing exposure to sediment contaminants and an even lower chance of fish experiencing harmful exposure. To add additional protection for salmonids,

[5] Travel rates estimated for the Action Area are as follows: Juvenile Chinook (less than 100 mm) travel at a median rate between 8.7 and 11.3 km/day (ODFW 2005; Knutson and Ward 1991); juvenile steelhead travel between 11.9 and 17.9 km/day (ODFW 2005; Knutson and Ward 1991); coho migration rates are slower than Chinook and steelhead, although specific rates were not provided in ODFW 2005.

water from the work areas will be tested during all dredging, capping, and offloading as part of water quality monitoring using chemical testing (See Section 3.2.4). Exceedence of designated water quality criteria will trigger BMPs to reduce the amount of sediment resuspension during dredging.

During offloading in the Columbia River portion of the Action Area, there is a very minimal risk that salmonids could be exposed to contaminants due to spillage while sediments are being rehandled from barge to truck/train. However, BMPs will be employed during offloading procedures to minimize the potential for spillage to occur. The timeline for the potential for exposure related to any spills that may occur during offloading is expected to span approximately 8 hours during each offloading event, over the period of in-water construction.

Following the interim dredging action within the Berth 411 Plus and Berth 410 areas, the exposed surface of the dredged area will contain chemical concentrations at least below 10 times the PEC value. Therefore, the concentration at the leave surface (the surface left after dredging) will be lower than the existing surface, thereby reducing existing exposure levels to aquatic organisms.

There is a small chance that fish could also be exposed to contaminants as a result of accidental spills from construction equipment. However, spills and accidental releases of dredged material during handling will be minimized and mitigated by implementing standard and appropriate material handling and containment procedures as described in Section 3.2.4.

Turbidity

Turbidity is expected to be limited, short term, and localized and is not expected to result in any long-term effects as a result of the proposed action (NMFS 2003). As described in Section 6.3.2.4, periodic spikes in turbidity do presently occur during low water conditions in the Terminal 4 area concurrent with normal operating conditions of the existing slips. In addition, there may be temporary increases in turbidity due to dredging and capping activities. The mechanisms by which mechanical clamshell dredging causes increased suspended sediment concentrations include the impact and withdrawal of the bucket from the substrate, the washing of material out of the bucket as it moves through the water column, and the loss of water as the sediment is loaded onto the barge (Hayes et al. 1984; Nightingale and Simenstad 2001). The duration of the highest turbidity exposure is expected to be on the order of hours as construction operations are not likely to occur on a continuous, 24-hours-a-day, 7-days–a-week schedule. Therefore, the most turbid conditions will be reduced during times of no construction activity and will increase again during the next construction period. This condition will be sustained over a period of 4 weeks of the in-water work window during dredging and in-water capping activities.

Research has shown that turbidity increases due to dredging are typically short-term and localized in nature and are close to the bottom of the water column. Suspended sediment concentrations vary throughout the water column, with larger plumes typically occurring at the bottom closer to the point of dredging. Even without suspended sediment controls, plume size decreases exponentially with movement away from the point of dredging both vertically and horizontally. In addition, increases in turbidity that result from dredging activities are typically of much less magnitude than increases caused by natural storm events (Nightingale and Simenstad 2001).

Generalized turbidity effects on fish depend on the amount and timing of exposure (NMFS 2004b). Because salmonids have evolved in systems that periodically experience short-term pulses of high suspended sediment, they are adapted to such exposures. Hence, adult and larger juvenile salmonids may be affected little by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjorn and Reiser 1991) although these events can produce behavioral effects, such as gill flaring and feeding changes (Berg and Northcote 1985). Some studies have shown that in waters with periodic turbidity equivalent to 23 NTUs, predation on salmonids may be reduced (Gregory 1993; Gregory and Levings 1998), an effect that may improve overall survival.

The potential effects of increased turbidity on salmonids with regard to dredging activities have been investigated in a number of studies (Servizi and Martens 1987 and 1992; Emmet et al. 1988; Simenstad 1988; Redding et al. 1987; Berg and Northcote 1985; Noggle 1978; Mortensen et al. 1976). There are several mechanisms of effect for suspended sediment levels during dredging, including direct mortality, gill tissue damage, physiological stress, and behavioral changes. Each of these potential effects with respect to dredging is discussed below.

Direct Mortality

Direct mortality from extremely high levels of suspended sediment has been documented at concentrations far exceeding those caused by typical dredging operations. Laboratory studies have consistently found that the 96-hour median lethal concentration (LC50) for juvenile salmonids occurs at levels above 6,000 mg/L (Stober et al. 1981; Salo et al. 1980; LeGore and DesVoigne 1973). However, typical samples collected adjacent to dredge locations (within approximately 150 feet) contain suspended sediment concentrations between 50 and 150 mg/L (Palermo et al. 1990; Havis 1988; Salo et al. 1979).

Based on an evaluation of seven clamshell dredge operations, LaSalle (1988) determined that suspended sediment levels of less than 700 mg/L at the surface and less than 1,100 mg/L at the bottom would represent the upper limit concentration expected adjacent to the dredge source (within approximately 300 feet). This concentration would decrease rapidly with distance due to settling and mixing. Concentrations of this magnitude could occur at locations with fine silt or clay substrates. Much lower concentrations (50 to 150 mg/L at 150 feet) are expected at locations with coarser sediment.

Because direct mortality occurs at turbidity levels that far exceed typical dredging operations, direct mortality from suspended sediment is not expected to occur during this project.

Gill Tissue Damage

Studies indicate that suspended sediment concentrations occurring near dredging activity are generally not high enough to cause gill damage in salmonids. Servizi and Martens (1992) found that gill damage was absent in underyearling coho salmon exposed to concentrations of suspended sediments lower than 3,143 mg/L. Redding et al. (1987) also found that the appearance of gill tissue was similar for control fish and those exposed to high, medium, and low concentrations of suspended topsoil, ash, and clay. Based on the results of these studies, juvenile and subadult salmonids, if present, are not expected to experience gill tissue damage even if exposed to the upper limit of suspended sediment concentrations expected during dredging.

Physiological Stress

Suspended sediments have been shown to cause physical stress in salmonids, but at concentrations higher than those typically caused by dredging. Subyearling coho salmon exposed to suspended sediment concentrations above 2,000 mg/L were physiologically stressed, as indicated by elevated blood plasma cortisol levels (Redding et al. 1987). Exposure to approximately 500 mg/L of suspended sediment for 2 to 8 consecutive days also caused stress, but to a much lesser degree (Redding et al. 1987; Servizi and Martens 1987). At 150 to 200 mg/L of glacial till, no significant difference in blood plasma glucose (a stress indicator) concentrations were observed. These results indicate that upper limit suspended sediment conditions near mechanical dredging activity of fine silt or clay (700 to 1,100 mg/L) can cause stress in juveniles if exposure continues for an extended period of time. Continued exposure is unlikely, however, due to the tendency for unconfined salmonids to avoid areas with elevated suspended sediment concentrations (Salo et al. 1980) and the intermittent nature of dredging operations. Typical sediment plumes caused by dredging do not create suspended sediment concentrations high enough to cause stress in juvenile salmonids (CTSF 2003).

Behavioral Effects

Behavioral responses to elevated levels of suspended sediment include feeding disruption and changes in migratory behavior (Servizi 1988, Martin et al. 1977). Several studies indicate that salmonid foraging behavior is impaired by high levels of suspended sediment (Bisson and Bilby 1982; Berg and Northcote 1985). Redding et al. (1987) demonstrated that yearling coho and steelhead exposed to high levels (2,000 to 3,000 mg/L) of suspended sediment did not rise to the surface to feed. Yearling coho and steelhead exposed to lower levels (400 to 600 mg/L), however, actively fed at the surface throughout the experiment. In these instances, the thresholds at which feeding effectiveness was impaired greatly exceeded the upper limit of expected suspended solids during dredging.

Adult migration may also be subject to disruption from suspended sediment. Adult salmonids are not necessarily closely associated with the shoreline and are less vulnerable to adverse impacts if they encounter turbid conditions. Whitman and Miller (1982) used volcanic ash from the eruption of Mount St. Helens to recreate highly turbid conditions faced by returning adult salmon. This study showed that, despite very high levels of ash, adult male Chinook were still able to detect natal waters through olfaction even when subjected to 7 days of total suspended sediment levels of 650 mg/L. Therefore, migratory or feeding disruptions are not expected to occur from dredging activities.

7.1.1.1.4 Nearshore Habitat

The Lower Willamette River is a migratory corridor for juvenile and adult salmonids discussed in this BA (Section 5). Nearshore habitat in Wheeler Bay used by salmonids will be affected, but not appreciably altered over the long term, as a result of Phase I activities, because the armor material proposed for the Wheeler Bay stabilization should be located in the dry during the time that salmonids would be in the area, much of the area already contains armor material, and additional habitat improvement activities are planned that will improve habitat over the long term.

All of the armor material to be placed in Wheeler Bay will occur at or above elevation +10 feet NGVD, in an area which is almost always dry. An analysis of USGS water level data from 1972 to 2004 and Hydrosphere Data from 1987 to 2004 showed that water levels in the Removal Action Area typically reach +9 to +10 feet less than 1 percent of the time from February to May/June, which overlaps the period that the highest concentrations of juvenile salmonids are expected to be in the Action Area (Anchor 2006a). Assuming a 1 percent frequency of inundation for this time period, the armor material would be inundated approximately 1.2 days on average during the 4 month time period. Based on mean monthly stage data for Portland, OR from 1973 to 2003 (same data source used in the water level analysis mentioned above), zero days of inundation are expected on average for the July through October time period (Corps of Engineers 2004). This time period corresponds to the time of year when the lowest concentration of juvenile fish is expected to be in the area. Additionally, for the November through February time period, mean monthly stage data indicates there would be zero days of inundation of armor material during this time period (Corps of Engineers 2004). Since this time of year is prone to storm activity, it is assumed that the armor would be inundated on the same frequency (1.2 days on average) as described for the February through June time period. Overall, it is expected that the armor material will be inundated for approximately 3 days on average throughout the year.

The armor material will cover 13,300 square feet between elevations +10 and +30 feet NGVD, which is approximately 30 percent of the total area to be regraded at Wheeler Bay. Currently, approximately half (6,300 square feet) of the area to be covered in armor material as part of Phase I currently consists of armor material, while the other half (7,000 square feet) of the area to be armored is characterized by sand/pebble substrate with debris. In addition, habitat improvements are planned for the area, as the entire Wheeler Bay shoreline stabilization footprint (approximately 43,280 square feet) will be planted with live willow stakings and hydroseeding between elevations +15 and +30 feet NGVD, and LWD will be placed between elevations +10 and +15 feet NGVD.

Thus, no loss of salmonid habitat is expected to occur in Wheeler Bay as the stabilization work and revegetation will improve nearshore habitat. Although armor material will be placed along the steepest portion of the shoreline, the net effect will be an improvement over existing conditions. Currently, the shoreline is eroding and is causing ongoing contamination to the nearshore sediments; existing vegetation is low growing, invasive, or nonexistent, and debris is strewn throughout the shore. The proposed shoreline stabilization work will stop the current erosion occurring in the bay and will prevent further contamination from entering the environment. In addition, the planned riparian plantings will improve vegetation conditions from the existing currently degraded setting. The vegetation work is being completed as an action to immediately improve the shoreline in Wheeler Bay as part of Phase I of the Removal Action until Phase II occurs and the full evaluation of impacts of the entire Removal Action can take place.

For the Head of Slip 3 cap, the substrate to be placed in the shallow water area above the timber bulkhead as part of the cap will be comprised of armor material, which is the same as the existing material in this area. The area below the timber bulkhead which will receive the armor wedge for stabilization does not currently have armor material; however, the nearshore habitat in Slip 3 that is being affected is contaminated and is located adjacent to active berths with vessel traffic, which may limit function as nearshore habitat. Moreover, the net effect and intention of the new Head of Slip 3 cap is to provide a habitat benefit to listed species.

There will be no alteration of nearshore habitat as a result of dredging in this project, as all dredging will occur at deep elevations.

As described in Section 3, conservation measures will be taken to avoid unnecessary impacts and minimize the negative effects of this action. The overall effect of work in this shoreline area is expected to be minimal because existing conditions in the project area are already heavily industrialized, existing and proposed substrate is similar, and fish use of the area is compromised. Post-project conditions of nearshore habitat will provide improved habitat benefits for salmonid species relative to existing conditions, as the overall effect of the action is expected to be a net benefit to listed species.

7.1.1.2 Effects on Critical Habitat

Designated critical habitat within the Action Area for the ESA-listed salmonids considered here consists of freshwater rearing sites, freshwater migration corridors, and certain associated essential physical and biological features. The status of these features was previously described in Section 6 and the potential effects on these features are shown in Table 7.

Table 7
Potential Effects on Sites and Biological Features Designated as PCEs

Site	Essential Physical and Biological Features	Effect from Proposed Action
Freshwater rearing	Water quantity and floodplain connectivity	No effect on water quantity or flows. Floodplain connectivity is already limited in the project reach by industrial activities and urbanization and will not undergo change due to the proposed project.
	Water quality and forage	Short-term effects to water quality will occur related to dredging and capping, but turbidity is expected to be limited, short term, and localized, and is not expected to result in any long-term effects. Resuspension of sediments and contaminants may occur during in-water work, but salmonids would not be expected be present or would be present in very low numbers; additionally, if present, they would not be expected to experience substantial effects because the duration of exposure to potentially resuspended chemicals will not be long in duration. Dredging and capping will temporarily disturb existing benthic organisms and habitat. However, due to existing compromised habitat (for all salmonids) and diet preferences (for Chinook), it is expected that impacts to juvenile salmonids due to

Site	Essential Physical and Biological Features	Effect from Proposed Action
		disturbance of the epibenthic prey community will be minimal. Effects to substrate are not expected to be a significant factor in juvenile salmon habitat quality as a result of substrate work at Wheeler Bay or at the Head of Slip 3 cap. Based on typical water level calculations for the Action Area (Anchor 2006a) the actual area covered by the armor material proposed for the Wheeler Bay shoreline stabilization will be dry much of the time as armor material will be above the expected typical water level for Wheeler Bay (See Section 7.1.1.1.4). The substrate to be placed in the shallow water area as part of the Head of Slip 3 cap will be comprised of armor material, which is the same as the existing material in this area. The area below the timber bulkhead which will receive the armor wedge for stabilization does not currently have armor material; however, the nearshore habitat in Slip 3 that is being affected is contaminated and is located adjacent to active berths with vessel traffic, which may limit function as nearshore habitat. Moreover, the net effect and intention of the new Head of Slip 3 cap is to provide a habitat benefit to listed species. Water quality monitoring will occur concurrent with dredging and capping activity in accordance with the 401 Water Quality Certification issued for the project. In addition, in-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be either not present or present in very low numbers. The work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31.
	Natural cover[1]	Natural cover is absent in the Removal Action Area; no effect on availability of natural cover.
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover	Passage will be impeded in the Removal Action Area during in-water work; project effects are likely to delay migration periodically for a period of hours, but will be limited to the duration of in-water work during dredging and capping, which will occur during the in-water work window when salmonids are expected to be either not present or present in very low numbers. See 'Water quality and forage', above. No effect on water quantity or flows. See 'natural cover,' above.

1 Shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

Sections 5 and 6 of this BA indicate that existing habitat conditions for rearing and migration are already of low quality. Given the context of the Action Area in an industrialized reach of the river, although short-term habitat impacts are likely, the long-term effect of the proposed action on critical habitat PCEs is anticipated to be beneficial. The project is not expected or intended to reduce the conservation value of critical habitat. Moreover, the project will serve to increase the habitat value of the area by removing contaminated sediments from the environment.

7.1.2 Interrelated/Interdependent and Cumulative Effects

The remainder of the Removal Action and cleanup of the Portland Harbor Superfund Site is slated to occur in future years as part of the harbor-wide RI/FS process, with the intent to provide a net benefit to species and habitat through cleanup of contaminated sediments. In addition, any (404[b][1]) compensatory mitigation completed as part of the future cleanup will provide higher quality habitat for listed species.

7.1.3 Regulatory Basis for the Effects Determination

The effects determination is the conclusion of the analysis of potential direct or indirect effects of the proposed activity on listed species and critical habitat. Regulatory guidance from the Final Section 7 Consultation Handbook (USFWS and NMFS 1998) was used to make the effects determination for the proposed activity as described below.

The range of conclusions that could result from the effects analysis for the effects determination includes:

- **No effect**—the appropriate conclusion when the action agency determines its proposed action will not affect listed species or critical habitat.
- **May affect, is not likely to adversely affect**—the appropriate conclusion when effects on listed species are expected to be discountable, or insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: 1) be able to meaningfully measure, detect, or evaluate insignificant effects; or 2) expect discountable effects to occur.
- **May affect, is likely to adversely affect**—the appropriate conclusion if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not

discountable, insignificant, or beneficial (see definitions of "is not likely to adversely affect").

A key factor in making an effects determination and distinguishing between a significant and insignificant effect is determining if the effect would be significant enough to cause a take. "Take," as defined by the ESA, includes such activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct [ESA §3(19)]. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering; harass is further defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding or sheltering (50 CFR §17.3).

7.1.4 Effects Determination

7.1.4.1 Effect Determination for Listed Species

As previously stated, the overall purpose of conducting the removal of sediment contamination in the Action Area is to reduce exposure to existing contaminants and to provide long-term benefits to prey species, as well as salmonids, by significantly improving overall benthic habitat conditions at Terminal 4. For this project, there are separate effect determinations for the listed fish species that are likely to occur in the Willamette River near where in-water work will occur versus the Columbia River near the offloading location. The below paragraphs detail the respective determinations for these species.

Species Likely to Occur near Columbia River Offloading Location

Based on the guidance and definitions provided above and the previously discussed project effects, the effect determination for species likely to occur near the Columbia River offloading location is that **this project may affect, but is not likely to adversely affect, Upper Columbia Chinook, Snake River spring/summer Chinook, Columbia River chum, Snake River fall Chinook, Snake River steelhead, Upper Columbia steelhead, Middle Columbia steelhead, Snake River sockeye, and**

Columbia River bull trout. Justifications for these determinations are provided below.

The project may affect these listed species because:

- The project will involve offloading contaminated sediments near shoreline areas.
- Short-term and localized impacts to water quality could result from potential offloading spills in the form of short-term increases in turbidity or resuspended contaminants.

However, the project is not likely to adversely these listed species because:

- Offloading activities will occur over the water and no in-water work will be required which could risk injury to fish. No turbidity increases are expected as a result of this activity. Any spills and accidental releases of dredged material during handling will be minimized and mitigated by implementing standard and appropriate material handling and containment procedures as described in Section 3.2.4.
- Additionally, due to adherence to the standard and appropriate material handling and containment procedures as described in Section 3.2.4, there is a low likelihood that dredged sediment will fall into the water during offloading. There is also a low likelihood that the particular sediment that would be dropped, if dropped, would be dropped in an amount and concentration which would impair fish. There is an even lower likelihood that fish would occur in the offloading area where sediment could drop during offloading, due to adherence to project work windows which require offloading to occur when fish are expected to either not be present or be present in low numbers. These combined likelihoods lead to a conclusion that effects to fish from potential sediment drops during offloading are both insignificant and discountable.

The basis for this conclusion is that potential project effects may occur ("may affect"), but are expected to be insignificant and are not anticipated to reach the scale where take occurs, or are discountable and extremely unlikely to occur ("not likely to adversely affect"). Take will not occur because effects are not expected to cause significant habitat modification, significant impairment or disruption of normal behavioral patterns, or increase the likelihood of injury to listed species, for the reasons listed above.

Species Likely to Occur near Willamette River In-water Work

In addition, based on the guidance and definitions provided above and the previously discussed project effects, the effect determinations for species present in the Willamette River is that **this project is likely to adversely affect Lower Columbia Chinook, Upper Willamette Chinook salmon, Lower Columbia coho, Lower Columbia steelhead, and Upper Willamette steelhead.** Justification for these determinations is provided below.

Although in-water work will occur during the in-water work window when listed fish are expected to either not be present or be present in very low numbers, it is possible that individual listed fish could be present in the Action Area. Thus, in-water work will occur with the risk that fish that are present could experience effects that are not discountable or insignificant.

Therefore, the "may affect, likely to adversely affect" determination is appropriate for these listed species that may be present for these reasons:

- Substrate disturbance and disturbance of benthic and epibenthic prey items will occur during dredging and capping. However, this effect will be short-term and temporary due to expected rapid recovery of the benthic community following dredging and/or capping, and no long-term modifications of salmonid prey species habitats are expected.
- Short-term and localized impacts to water quality could result in the form of short-term changes in water column DO, turbidity, and resuspended contaminants for fish and fish prey, and there is a risk of acute contaminant exposure to fish that may be in the area. However, direct fish mortality or stress from suspended sediment is not expected to occur, any reduction in

DO beyond background is expected to be localized and temporary in nature, and water quality effects are not expected to be at a level that would affect the abundance of water column prey items.

The basis for this conclusion is as follows within the context of the Section 7 regulations listed above. Because the likelihood of the potential effects cannot be entirely discounted in the short term, their extent cannot be labeled as insignificant, and their overall benefits are not contemporaneous, a "may affect, likely to adversely affect" determination is appropriate. Effects are expected to cause habitat (and prey habitat) impacts, with a risk of impairment or disruption of normal behavioral patterns, and with a comparable risk of impact to listed fish that may be present during construction, for the reasons listed above. However, the conservation measures given above and discussed in Section 3 will minimize the likelihood of take for each project element.

7.1.4.2 Effect Determination for Critical Habitat

Based on the guidance and definitions provided above and the previously discussed project effects, the effect determination for species likely to be present at the Columbia River offloading area and for species likely to be present at the Willamette River project location is that this project **may affect, but is not likely to adversely affect, designated critical habitat for Upper Columbia Chinook, Snake River spring/summer Chinook, Snake River fall Chinook, Snake River steelhead, Upper Columbia steelhead, Middle Columbia steelhead, Snake River sockeye, Lower Columbia Chinook, Upper Willamette Chinook salmon, Columbia River chum, Lower Columbia steelhead, and Upper Willamette steelhead.** In the event that critical habitat for Lower Columbia River coho is either proposed or designated in the future, it is further concluded that this project would not adversely modify critical habitat, if proposed, for Lower Columbia River coho salmon, and may affect, but would not be likely to adversely affect critical habitat, if designated, for Lower Columbia River coho salmon. Justification for these determinations is provided below.

The project may affect designated critical habitat because:

- Temporary substrate disturbance will occur during dredging and capping, and material will be placed below the OHWM within designated critical habitat.
- Temporary and localized impacts to water column habitat could result in the form of short-term changes in water column DO, turbidity, and resuspended contaminants for fish and fish prey.
- Fish migration may be delayed in the Removal Action Area during in-water work periodically for a period of hours.

However, the project is not likely to adversely affect designated critical habitat because:

- In-water work (including offloading activities) will be restricted to the work window as described previously.
- Substrate disturbance effects to prey species will be short-term due to expected rapid recovery of the benthic areas following dredging and/or capping, and no long-term modifications of salmonid prey species habitats are expected.
- For the Head of Slip 3 cap, substrate to be placed in shallow water in the cap location landward of the timber bulkhead will be comprised of armor material, which is the same as existing substrate in this location. Below the bulkhead, armor material does not currently exist; however, the nearshore habitat here is contaminated and is located adjacent to active berths with vessel traffic, which limits its function as nearshore habitat. Moreover, the net effect and intention of the new Head of Slip 3 cap is to provide a critical habitat benefit through removal of a source of contamination.
- Based on typical water level calculations for the Action Area (Anchor 2006a), average water levels when fish are expected to be using the area the most (February through May) are expected to be close to +9 to +10 feet NGVD. For the Wheeler Bay shoreline stabilization, the elevation where armor material will be placed is between +10 and +30 feet NGVD, which is above the expected water level. The expected water level during the remainder of the

year is expected to be equal to or lower than +9 to +10 feet NGVD because the February through May time period encompasses a majority of the rainy season. In addition, habitat improvements, including riparian plantings and placement of LWD, will occur along the entire Wheeler Bay shoreline.

- There will be no alteration of nearshore habitat as a result of dredging, as all dredging will occur at deep elevations.
- Impacts to water column habitat are expected to be temporary and localized, and no long-term water quality effects are expected. Any reduction in DO beyond background is expected to be localized and temporary in nature, and water quality effects are not expected to be at a level that would affect the abundance of water column prey items.
- There will be no effect on water quantity or flows.
- There will be no effect on availability of natural cover.
- Floodplain connectivity will not undergo change due to the proposed project.
- Fish passage effects, if occurring, would be limited to the duration of in-water work during dredging and capping, which will occur during the in-water work window when salmonids are expected to be present in very low numbers.
- Any spills and accidental releases of dredged material during handling will be minimized and mitigated by implementing standard and appropriate material handling and containment procedures as described in Section 3.2.4.

The basis for this conclusion is that potential project effects will occur ("may affect"), but are not expected to jeopardize the continued existence of an endangered or threatened salmon or steelhead ESU or result in the destruction or adverse modification of critical habitat ("not likely to adversely affect"), for the reasons listed above. Information presented above shows that poor conditions for rearing and migration near Terminal 4 are already significant factors for the affected species. The effects of this action will lower the value of water quality and passage in the action area over the short term, but will not affect the conservation value of the Action Area over the long term for the ESUs with critical habitat considered here. Although short-term effects are likely, the long-term effect of the proposed action on critical habitat PCEs are expected and intended to be beneficial.

8 REFERENCES

Allen, R.L., and T.K. Meekin. 1973. An evaluation of the Priest Rapids chinook salmon spawning channel, 1963-1971. Washington Department of Fisheries, Technical Report 11: 1-52, Olympia, Washington.

AMEC 2006. Results of May 2006 Sediment Sampling-Post Toe Slope Removal, Port of Portland Marine Terminal 4, Berths 410 and 411, Portland, Oregon_Draft. July 27, 2006.

Anchor Environmental (Anchor). 2005. Biological Assessment. NW Natural “Gasco” Site Removal Action. May 2005.

Anchor. 2006a. Water Level Data Analysis. Terminal 4 Early Action Project, Portland, Oregon. May 2006.

Anchor. 2006b. Design Analysis Report (Prefinal 60 Percent Design Deliverable). Terminal 4 Early Action. Prepared for: Port of Portland. December 2006.

Anchor. 2007. Abatement Measures Proposal. Terminal 4 Removal Action Project. Prepared for: Port of Portland. October 25, 2007.

Ash Creek Associates, Inc. and NewFields (Ash Creek/NewFields). 2007. Remedial Investigation Report Terminal 4 Slip 1 Upland Facility. August 2007.

Beamish, R.J. 1972. Design of a trap net for sampling shallow water habitats. Fisheries Research Board of Canada Technical Report 305.

Becker, D.C. 1970. Temperature, timing, and seaward migration of juvenile chinook salmon from the central Columbia River. Battelle Northwest.

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Berg, L, and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (Oncorhynuchus kisutch) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences. Vol. 42, no. 8, pp. 1410-1417.

Bisson, P.A., and R.E. Bilby. 1982. Avoidance of Suspended Sediment by Juvenile Coho Salmon. North American Journal of Fisheries Management 1982;2:371–374.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W.R. Meehan, editor Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19:83-138.

Bjornn, T.C., D.R. Craddock, and D.R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon (*Oncorhynchus nerka*). Transactions of the American Fisheries Society 97: 360-373.

Blasland, Bouck, & Lee, Inc. (BBL). 2004a. Work Plan, Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Port of Portland, Portland, Oregon. February 23.

BBL. 2004b. Site Characterization Report, Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Port of Portland, Portland, Oregon. September 17.

BBL. 2005. Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Public Review Draft. Port of Portland, Portland Oregon. May 31, 2005.

Bottom, D. L., K. K. Jones, T. J. Cornwell, A. Gray, and C. A. Simenstad. 2005. Patterns of Chinook salmon migration and residency in the Salmon River Estuary (Oregon). Est. Coastal Shelf Sci. 1:79-93 .

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, and D. Geist. 1990. Lower Snake River compensation plan salmon hatchery evaluation program. 1989 Annual Report to U.S. Fish and Wildlife Service (Cooperative Agreement 14-16-0001-89525).

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. Technical Memorandum NMFS-NWFSC-27. August 1996

Cannamela, D.A. 1992. Potential impacts of releases of hatchery steelhead trout "smolts" on wild and natural juvenile chinook and sockeye salmon. Idaho Department of Fish and Game, White Paper, Boise.

Chapman, D., C. Pevan, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc., Boise, Idaho.

City of Portland. 2001. Willamette River Design Notebook, Portland, Oregon.

City of Portland. 2004. Public Review Draft - Framework for Integrated Management of Watershed Health. City of Portland Endangered Species Program (http://www.fish.ci.portland.or.us/pdf/framework_0304.pdf).

Contaminated Sediments Task Force (CSTF). 2003. Literature Review of Effects of Resuspended Sediments Due to Dredging Operation. Prepared by Anchor Environmental, Irvine California.

Cramer, D. P., and S. P. Cramer. 1994. Status and population dynamics of coho salmon in the Clackamas River. Tech. Rep., Portland General Electric Co., 105 p. (Available from Portland General Electric Co., 33831 SE Faraday Rd., Estacada, OR 97023.)

Crowe, W.R. 1950. Construction and use of small trap nets. Progressive Fish-Culturist 12:185-192.

Ellis Ecological Services (EES). 2003. Juvenile salmonid residence times in Portland Harbor. NOAA Fisheries 4(d) Scientific Take Report. February 2003.

Emmett, R.L., G.T. McCabe Jr., and W.D. Muir. 1988. Effects of the 1980 Mount St. Helens eruption on Columbia River estuarine fishes: implications for dredging in northwest estuaries. Pages 75-91 in C.A. Simenstad, ed. Effects of Dredging on Anadromous Pacific Coast Fishes. University of Washington, Seattle, Washington.

Farr, R.A., and D.L. Ward. 1993. Fishes of the lower Willamette River, near Portland, Oregon. Northwest Science, Vol. 67. No. 1.

Foster, C.A. 1991. Fish passage at Willamette Falls in 1990: Portland, Oregon Department of Fish and Wildlife. Columbia River Management, Annual Report, 33p.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River – past and present. U.S. National Marine Fisheries Service Spec. Sci. Rep. Fish. 618:37 p.

GeoSyntec Consultants (GeoSyntec). 2005. Erosion and Sediment Control Manual. Prepared for Oregon State Department of Environmental Quality. April 2005.

Gregory, R.S. 1993. Effect of turbidity on the predator avoidance behavior of juvenile Chinook salmon (Oncorhynchus tshawytcha). Canadian Journal of Fisheries and Aquatic Sciences 50:241-246.

Gregory, R.S. and C.D. Levings. 1998. "Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon." Transactions of the American Fisheries Society 127: 275-285.

Hart Crowser. 2000. Remedial Investigation Report, Terminal 4, Slip 3 Sediments (Volume I) with tables, figures, and Appendices A through E, Port of Portland, Portland, Oregon available in hard copy and electronically), April 18, 2000.

Hart Crowser. 2002. Dredge Material Characterization Study Marine Terminal 4, Slip 3. Prepared for the Port of Portland, February 19, 2002.

Hassler, T.J. 1987. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--coho salmon. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.70). 19 pages.

Havis, R. N. 1988. "Sediment resuspension by selected dredges," Environmental Effects of Dredging Technical Note EEDP-09-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS

Hayes, D.F., G.L. Raymond, and T.N. McLellan. 1984. Sediment resuspension from dredging activities. Pp. 72-82. In: *Dredging and dredged material disposal, Proceedings Conference Dredging '84* Clearwater Beach, FL: American Society of Civil Engineers.

Healey, M.C. 1991. Life history of chinook salmon (Oncorhynchus tshawytscha). Pp. 311-294 in C. Groot and L. Morgolis (eds.), Pacific Salmon Life Histories. UBC Press. Vancouver, B.C., Canada.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Kendra, and D. Ortman. 1985. Stock assessment of Columbia River anadromous salmonids; Volume I: Chinook, coho, chum, and sockeye salmon stock summaries. Project No. 83-335. Portland, Oregon: Bonneville Power Administration.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids. Volume III: Washington subbasins below McNary Dam. Bonneville Power Administration. Project No. 88-108, 1077 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife, Public Information Officer - PJ, P.O. Bo3621, Portland, OR, 97208.)

Johnson, O. W., T. A. Flagg, D.J. Maynard, G.B. Milner, and F.W. Waknitz. 1991. Status review for Lower Columbia River Coho Salmon. NOAA F/NWC-202. June 1991.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Naples. 1997. Status Review of Chum Salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-32. December 1997.

Kostow, K. (editor). 1995. 1994 Biennial report of the status of wild fish in Oregon. Oregon Dep. Fish Wildl., Portland. (Available from Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR 97207.)

Knutsen, C.J. and D.L. Ward. 1991. Behavior of juvenile salmonids migrating through the Willamette River near Portland, Oregon: Oregon Department of Fish and Wildlife, Fish Division, Information Report No. 91-5, 17 p.

Larson, K.W. and C.E. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. Pages 104-110 in C.A. Simenstad ed. Effects of Dredging on anadromous Pacific coast fishes. Washington Sea Grant. Seattle, WA.

LaSalle, M.W. 1988. Physical and chemical alterations associated with dredging: an overview. Pages 1-12 in C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington, Seattle, Washington.

LeGore, R.S., and D.M. Des Voigne. 1973. Absence of acute effects on threespine sticklebacks (*Gasterosteus aculeatus*) and coho salmon (*Onchorynchus kisutch*) exposed to resuspended harbor sediment contamination. Journal of the Fisheries Research Board of Canada 30(8): 1240-1242.

Lower Willamette Group (LWG). 2004. Portland Harbor RI/FS Programmatic Work Plan. April 23.

Martin, J.D., E.O. Salo and B.P Snyder. 1977. Field bioassay studies of the tolerance of juvenile salmonids to various levels of suspended solids. University of Washington School of Fisheries Research Institute. Seattle, WA. FRI-UW-7713.

McGraw, K.A. and D.A. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. Pages 113-131 in C.A. Simenstad ed. Effects of Dredging on anadromous Pacific coast fishes. Washington Sea Grant. Seattle, WA.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distributions and life histories. American Fisheries Society Special Publication 19: 47-82.

Mortensen, D.G., B.P. Snyder, and E.O. Salo. 1976. An analysis of the literature on the effects of dredging on juvenile salmonids. University of Washington. Fisheries Research Institute, FRI-UW-7605.

Myers, J.M. R.G. Kope, G.J. Bryant, D.Teel, L.J. Lierheimer, T.C. Wainwright, W. S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. February 1998.

National Marine Fisheries Service (NMFS). 1991. Status review for lower Columbia River coho salmon. NOAA F/NWC-202: June 1991.

NMFS. 1996. Making endangered species act determinations of effect for individual or grouped actions as the watershed scale. National Marine Fisheries Service Environmental and Technical Services Division Habitat Conservation Branch.

NMFS. 2001. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Dredged Material Management Plan for the McNary Reservoir and Lower Snake River Reservoirs (NMFS No. WSB-01-301).

NMFS. 2002. Endangered Species Act – Section 7 Consultation and Magnuson-Stevens Act Essential Fish Habitat Consultation. McCormick and Baxter Biological Opinion. August 19, 2002.

NMFS. 2003. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Middle Waterway Remediation Action, Commencement Bay Nearshore/Tideflats Superfund Site, Tacoma, Washington. NMFS Tracking No.: 2003/00574. September 2003.

NMFS. 2004a. Endangered Species Act - Section 7 Consultation Biological Opinion and Conference Opinion & Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation City of Portland Maintenance Dredging at Fire Station No. 6 Harbor, Willamette River, Willamette River/Columbia River HUC, Multnomah County, Oregon (Corps No. 200200811). NOAA's National Marine Fisheries Service Northwest Region. October 14.

NMFS. 2004b. Endangered Species Act - Section 7 Consultation Programmatic Biological Opinion and Conference Opinion & Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Revised Standard Local Operating Procedures for Endangered Species (SLOPES III) to Administer Certain Activities Authorized or Carried out by the Department of the Army in the State of Oregon and on the North Shore of the Columbia River. November 30, 2004. NOAA's National Marine Fisheries Service Northwest Region.

NMFS 2005a. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Northwest Natural Removal Action at the Gasco Site, Portland Harbor, Willamette River, Multnomah County, Oregon..

NMFS. 2007. Endangered Species Act Status of West Coast Salmon and Steelhead. Updated June 15, 2007. Available at: http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Index.cfm. (Included in Appendix B).

Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Research and Development Section, Corvallis, and Ocean Salmon Management, Newport, Oregon.

Nightingale, B. and C. Simenstad. 2001. White Paper – Dredging Activities: Marine Issues. Submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. University of Washington, School of Aquatic and Fishery Sciences, Wetland Ecosystem Team. Seattle, Washington.

Noggle, C.C. 1978. Behavioral, physiological and lethal effects of suspended sediment on juvenile salmonids. Master's thesis. University of Washington, Seattle, Washington.

Olsen, E. A., P. M. P. Beamesderfer, M. L. McLean, and E. S. Tinus. 1994. Salmon and steelhead stock summaries for the Deschutes River Basin: An interim report. Oreg. Dep. Fish Wildl., Portland, 136 p.

Oregon Department of Environmental Quality (Oregon DEQ). 2003. Oregon 303d list. http://www.deq.state.or.us/wq/303dlist/303dpage.htm

Oregon DEQ. 2004. Laboratory Analytical Storage and Retrieval. ftp://waterquality.deq.state.or.us/wq/.

Oregon DEQ and U.S. Environmental Protection Agency (USEPA). 2002. Biological Assessment for McCormick and Baxter Creosoting Company, Portland, Oregon. June

Oregon Department of Fish and Wildlife (ODFW). 1994. Oregon River Information System. Available from ODFW, Corvallis, OR.

ODFW. 2000. Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources. Oregon Department of Fish and Wildlife. June 2000.

ODFW. 2005. Biology, Behavior, and Resources of Resident and Anadromous Fish in the Lower Willamette River, Final Report of Research, 2000-2004. Edited by Thomas Friesen, ODFW. Prepared for City of Portland Bureau of Environmental Services, Endangered Species Act Program.

Palermo, M.R., J.H. Homziak, and A.M. Teeter. 1990. Evaluation of clamshell dredging and barge overflow, Military Ocean Terminal, Sunny Point, North Carolina. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg Mississippi. March, 1990.

Parsons Brinckerhoff. 2002. Marine Terminal Master Plan 2020, Volume 1, Section 3, Baseline Environmental Conditions. August 2002.

Peery, C.A., and T.C. Bjornn. 1991. Examination of the extent and factors affecting downstream emigration of chinook salmon fry from spawning grounds in the upper Salmon River. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Unpublished Report, Moscow.

Peven, C.M. 1990. The life history of naturally produced steelhead trout from the Mid-Columbia River basin. Master's thesis, University of Washington, 1990.

Port of Portland and Ellis Ecological Services (Port of Portland and EES). 2004a. Biological Assessment – Bank Excavation and Backfill Remedial Action Marine Terminal 4, Slip 3 Upland Facility: Addressing Potential Impacts on Federally Listed and Wildlife and their Habitats. Prepared for the U.S. Army Corps Of Engineers.

Port of Portland and EES. 2004b. Biological Assessment – Cantilevered Sheetpile Wall Installation, Marine Terminal 4, Slip 3: Addressing Potential Impacts on Federally Listed Fish and Wildlife and Their Habitat. Prepared for the U.S. Army Corps Of Engineers.

Redding, M. J., C.B. Schreck, and F.H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Trans. of the Am. Fish. Soc. 116:737-744.

Reimers, P.E., and R.E. Loeffel. 1967. The length of residence of juvenile fall chinook salmon in selected Columbia River tributaries. Fish Comm. Oreg. 13, 5-19 p.

Reisenbichler, R. R., J. D. McIntyre, M. F. Solazzi, and S. W. Landino. 1992. Genetic variation in steelhead of Oregon and northern California. Transactions of the American Fisheries Society 121:158-162.

Salo, E.O. 1991. Life history of chum salmon (Oncorhynchus keta) Pages 231-309 in Groot. C. and L. Margolis (eds.). 1991 Pacific salmon life histories. Vancouver, British Columbia.

Salo, E.O., T.E. Prinslow, R.A. Campbell, D.W. Smith, and B.P. Snyder. 1979. Trident dredging study: the effects of dredging at the U.S. naval submarine base at Bangor on outmigrating juvenile chum salmon, *Oncorhynchus keta*, in Hood Canal, Washington. Fisheries Research Institute, FRI-UW-7918, College of Fisheries, University of Washington, Seattle.

Salo, E.O, N.J. Bax, T.E. Prinslow, C.J. Whitmus, B.P. Snyder, and C.A. Simenstad. 1980. The effects of construction of naval facilities on the outmigration of juvenile salmonids from Hood Canal, Washington. FRI-UW-8006. University of Washington College of Fisheries, Fisheries Research Institute. April 1980.

Schreck, C. B. H. W. Li, R. C. Jhort, and C. S. Sharpe. 1986. Stock identification of Columbia River chinook salmon and steelhead trout. Final report to Bonneville Power Administration, Portland, Oregon (Project 83-451).

Servizi, J.A. 1988. Sublethal Effects of Dredged Sediments on Juvenile Salmonids. Pages 57-63 in C.A. Simenstad, ed. Effects of dredging on anadromous Pacific coast fishes. University of Washington, Seattle, Washington.

Servizi, J.A. and D.W. Martens. 1987. Some effects of suspended Fraser River sediments on sockeye salmon (*Oncorhynchus nerka*). Page 254-264 in H.D. Smith, L. Margolis, and C.C.

Wood, eds. Sockeye salmon (*Oncorhynchus nerka*) population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Servizi, J.A., and D.W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. Can. J. Fish. Aquat. Sci. 49:1389-1395.

Simenstad, C.A. 1988. Effects of dredging on anadromous Pacific Coast fishes. Workshop Proceedings Sept 8-9, 1988. University of Washington, Seattle, Washington.

Southworth, G.R., J.J. Beauchamp, and P.K. Schmeider. 1978. Bioaccumulation potential of polycyclic aromatic hydrocarbons in *Daphnia pulex*. Water. Res. 12:973-977.

Spence, BC, GA Lomnicky, RM Hughes, RP Novitski. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR

Stober, Q.J., R.W. Tyler, and C.E. Petrosky. 1983. Barrier net to reduce entrainment losses of adult kokanee from Banks Lake, Washington. North American Journal of Fisheries Management 3:331-354.

Stober, Q.J., B.D. Ross, C.L Melby, P.A. Dimmel, T.H. Jagielo, and E.O. Salo. 1981. Effects of Suspended Sediment on Coho and Chinook Salmon in the Toutle and Cowlitz Rivers. FRI-UW-8124. University of Washington College of Fisheries, Fisheries Research Institute. November 1981.

USACE (U.S. Army Corps of Engineers). 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual. Engineer Research and Development Center. Environmental Laboratory. ERDC/EL TR-03-1. Vicksburg, Mississippi.

USACE. 2004. Portland-Vancouver Harbor Information Package, second addition, Reservoir Regulation and Water Quality Section. November 2004.

U.S. Environmental Protection Agency (USEPA). 2006. Action Memorandum for a Removal Action at the Port of Portland Terminal 4 site within the Portland Harbor Superfund Site, Portland, Multnomah County, Oregon. May 11, 2006.

USEPA. 2007. Letter from Deborah Yamamoto, USEPA to Tom Imeson, Port of Portland, RE: August 22, 2007 Request for Realignment of T4 Removal Schedule; Resolution of 60% Design Disputed Comments; Administrative Order on Consent for Removal Action (AOC), Docket No. 10-2004-0009. November 15, 2007.

U.S. Fish and Wildlife Service (USFWS). 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates. U.S. Fish and Wildlife Service Biological Report 82(11). U.S. Army Corps of Engineers, TR EL-82-4.

USFWS. 2002. Endangered and Threatened Wildlife and Plants; Withdrawal of Proposed Rule to List the Southwestern Washington/Columbia River Distinct Population Segment of the Coastal Cutthroat Trout as Threatened. Available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2002_register&docid=fr05jy02-20.pdf

USFWS. 2004. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List Three Species of Lampreys as Threatened or Endangered. Available at: http://www.fws.gov/pacific/ecoservices/endangered/listing/pdf/Lamprey_90Day_FinalRule.pdf

USFWS. 2006. The Endangered Species Program website. Accessed on December 4, 2007. Available at: http://www.fws.gov/endangered.

USFWS. 2007. National Bald Eagle Management Guidelines. May 2007. Available at: http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf

USFWS and NMFS. 1998. Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. March 1998. Final.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes (WDF et al.). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Available from Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501.

Weitkamp, L. A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon and California. NOAA Technical Memorandum NMFS-NWFSC-24.

Whitman, L.J. and R.J. Miller. 1982. The phototactic behavior of Daphnia magna as an indicator of chronic toxicity. Proceedings of the Oklahoma Academy of Science. 62:22-37.

Willamette Restoration Initiative (WRI). 1999. Restoring the Willamette Basin: Issues and Challenges. Prepared by the Institute for the Northwest.

WRI. 2004. Website: http://www.oregonwri.org/