Biological Assessment

PACIFIC SOUND RESOURCES SUPERFUND SITE

FINAL

SEATTLE, Washington

FEBRUARY 2002

US Army Corps of Engineers®
Seattle District

EPA

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) is currently planning remedial actions in Elliott Bay, Pacific Sound Resources-Marine Sediment Unit (PSR-MSU) Seattle, Washington (Figure 1). The remedial actions are planned along the shoreline, intertidal, and subtidal waters of Elliott Bay, specifically the PSR-MSU Superfund Site.

Remedial activities in PSR-MSU are federal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are therefore required to substantively comply with the Endangered Species Act (ESA). Substantive compliance with ESA means that EPA will prepare an assessment of effects on listed species for any "major construction activity" within or at the CERCLA action site in question that is located in the vicinity of listed species or designated critical habitat.

The intent of the proposed project is to complete the remedial activities for the Pacific Sound Resources Superfund Site. Specifically, remediation of the PSR-MSU site includes sediment dredging and capping. EPA will also create and enhance intertidal habitat at the site to provide a connected intertidal corridor along a portion of PSR-MSU shoreline.

These activities will occur between July 15, any year and February 15 any year, pending further consultations with resource agencies. However, EPA will be in the process of refining project design through the remainder of the design phase until 100% design is achieved.

The construction activities include:

- Placement of dredged material (silty sand) and borrow material (sand and gravel) to form a subtidal cap over contaminated marine sediments.
- Removal of existing pilings, excavation and disposal of sediments in the Crowley Marine area and creation of shallow subtidal and intertidal habitat.

This Biological Assessment (BA) evaluates the potential effects of these actions on federal proposed or listed threatened and endangered species. The majority of information contained in the BA description of the project was obtained from the 90% design by URS Greiner and Appendix K (Roy F. Weston, Inc.) from the RI/FS of 1998. The federally listed species are:

- Pacific Sound Chinook Salmon (*Oncorhynchus tshawytscha*)
- Bull Trout (*Salvelinus confluentus*)
- Stellar Sea Lion (*Eumetopias jubatus*)
- Humpback Whale (*Megaptera novaeangliae*)
- Bald Eagle (*Haliaeetus leucocephalus*)
- Leatherback Sea Turtle (*Dermochelys coriacea*)
- Marbled Murrelet (*Brachyramphus marmoratus marmoratus*)

For this assessment, EPA developed a more extensive documentation in their analysis of effects on two of the listed species: Puget Sound chinook salmon and bull trout. EPA's rationale for this approach is based on the high likelihood of some effect on these species and because the majority of the work will be conducted in important habitat for both species. As such, the majority of this document is devoted to a discussion of the probable effects on these two species. The remainder of the listed species are also discussed, but with less extensive analysis and documentation. This BA contains the following discussions in order of appearance in the document:

1. Description of the Proposed Action
2. Description of the Action Area
3. Description of the Biological Environment
4. Description of Life Requirements of Chinook Salmon and Bull Trout
5. Description of Baseline Assessment of Conditions for Chinook Salmon and Bull Trout
6. Description of Effects Analysis
7. Description of Other Listed Species with Effects Analysis
8. Conclusions

Based on the information provided in this biological assessment, EPA concludes that the proposed action is not likely to jeopardize the continued existence of the above listed species. EPA determined the following effects for each species based on the destruction or adverse modification of designated critical habitat.

- Pacific Sound Chinook salmon: **May affect, not likely to adversely affect**
- Bull Trout: **May affect, not likely to adversely affect**
- Stellar Sea Lion: **No effect**
- Humpback Whale: **No effect**
- Bald Eagle: **May affect, not likely to adversely affect**
- Leatherback Sea Turtle: **No effect**
- Marbled Murrelet: **No effect**

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is currently planning remedial actions in Elliott Bay, Seattle, Washington (Figure 1). The remedial actions are planned within the subtidal waters of Elliott Bay, specifically the Puget Sound Resources Superfund Site.

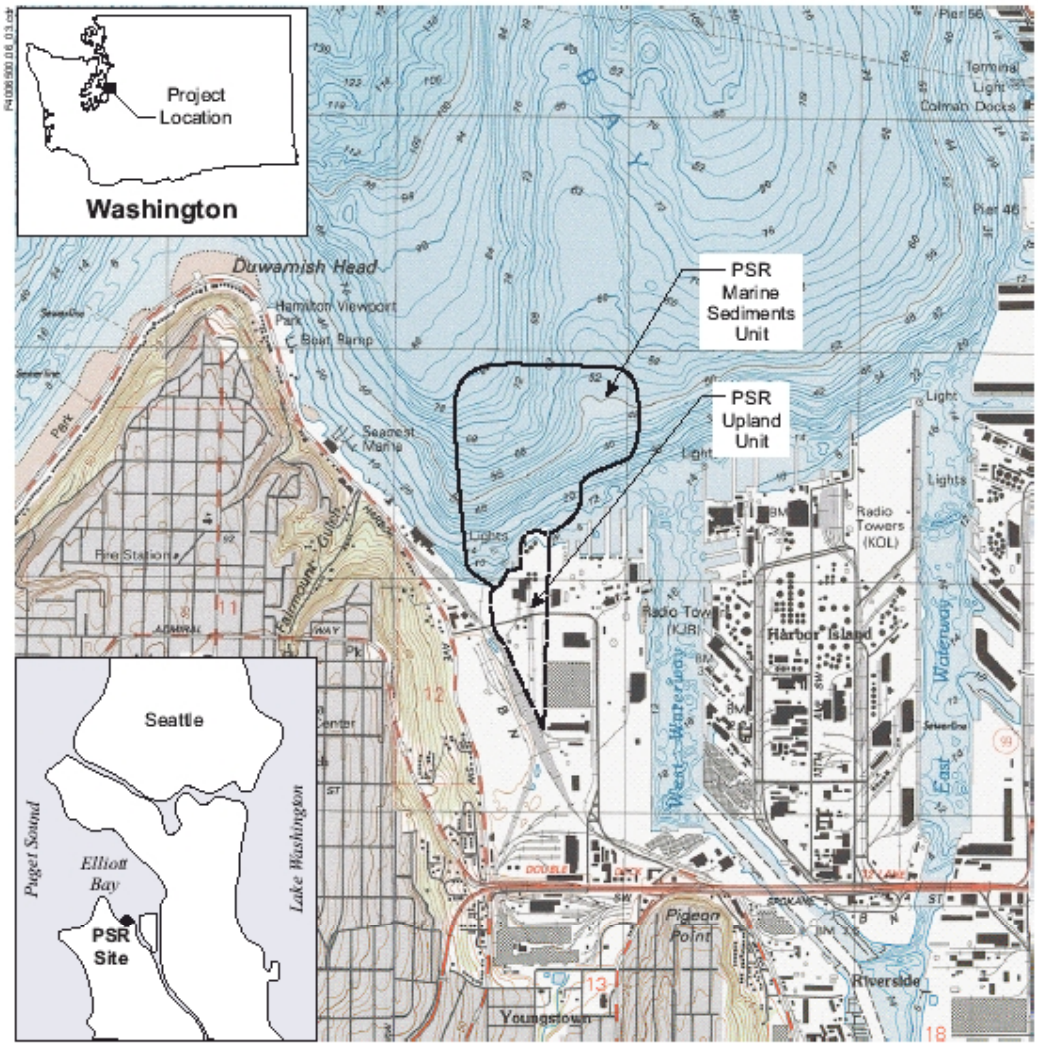
Remedial activities in Elliott Bay are federal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are therefore required to substantively comply with the Endangered Species Act (ESA). Substantive compliance with ESA means that EPA will prepare an assessment of effects on listed species for any "major construction activity" within or at the CERCLA action site in question that is located near listed species or designated critical habitat.

The Pacific Sound Resources Superfund Site (PSR) was formerly known as the Wyckoff West Seattle Wood-Treating Facility and was in operation from 1909 to 1994. For ease of investigation, the site was divided into two operable units: the upland unit and the MSU, an area encompassing approximately 200 acres in Elliott Bay and 2,000 feet of shoreline. The upland units remedial action was initiated in 1994 and completed in 1998. The wood treating chemicals used at the site included creosote, pentachlorophenol, and various metals-based solutions.

EPA has conducted two phases of early cleanup actions on the upland portion of the site. The first phase was to stabilize the site and demolish on-site structures. The second phase was to control the contaminants that were continuing to seep into the water of Elliott Bay. In 1995, approximately 4,000 cubic yards (cy) of highly contaminated soil and process sludge were removed from the site. In 1996, the second phase began by placing a subsurface physical containment barrier (slurry wall) to prevent light non-aqueous phase liquid (LNAPL) migration into Elliott Bay. This also helped to reduce the tidal influence on the sites' ground water. The slurry wall is 1200 feet in length to an average depth of 40 feet below ground surface. In 1998, a cap was completed to prevent runoff of contaminated soil, exposure to on-site workers, and minimize infiltration of storm water to groundwater.

EPA will now enter into the next phase of clean up for the site by concentrating on the Marine Sediments Unit that has been identified as part of the Superfund Site. This unit contains both intertidal and subtidal areas.

Figure 1 Project Location



Map created with TOPO!™ © 1997 Wildflower Productions, www.topo.com, based on USGS topographic map

Note: Contours shown in meters

0 0.5 1.0

Approximate Scale in Miles

Job No. 53-F4006500.06

Figure 1-1

PSR Upland and Marine Sediments Unit Location Map

EPA REGION 10

065-RD-RD-101L
PSR Superfund Site

2.0 DESCRIPTION OF PROJECT AREA AND ACTION AREA

2.1 Physical Features

The PSR site lies near the center of Puget Sound Basin between the Cascade Mountain Range and the Olympic Mountains. The geomorphology of the Puget Sound Basin has been shaped by several episodes of Pleistocene glaciation, which have resulted in a westward-sloping, gently rolling drift plain cut by many wide, steep-sided troughs.

The Duwamish River is a major drainage of the western slope of the Cascade Mountain range, and enters Puget Sound from the south at Elliott Bay, a protected, deep-water harbor. The PSR-MSU cap design limits encompass approximately 66 acres of Elliott Bay adjacent to and offshore of the Upland Unit (Figure 1). The Elliott Bay shoreline has been extensively developed for urban, port, and industrial land uses; the area surrounding the site is principally used for water-dependant industries. The mouth of the Duwamish River's West Waterway is located approximately 0.3 mile east of the PSR-MSU site.

Unconsolidated sediments dominate the project vicinity. The sedimentary bedrock of the Blakely Formation outcrops at Alki Point, about 1 mile west of the site, and at the west side of Beacon Hill, approximately 2 miles east of the site. No deep borehole explorations (past or current) have encountered bedrock at the PSR site, but the Blakely Formation is expected to underlie the site at approximately 340 to 680 feet based on regional data from geophysical surveys and nearby soil borings (Yount and Holmes 1992).

Nearly all intertidal wetlands and shallow subtidal aquatic habitats in the vicinity of the MSU have been eliminated as a result of urban and industrial development. There are two pocket beaches at the head of the West and Main Slips along PSR shoreline that contain limited shallow subtidal aquatic habitats. Along the toe of the riprap, shoreline banks are thin bands of mud- and sandflats. With the MSU located in a transition zone between the estuarine environment of the Duwamish River and the marine environment of Elliott Bay, the substrates and waters adjacent to the site contain habitat characteristics common to both environments.

Bottom depths within the MSU range from intertidal to over 200 feet deep; with a steeply sloped configuration from 6 to 20 (or greater) percent slope. The steepest slopes are nearshore, and slopes gradually decrease with increasing distance offshore.

Tidal elevations range from extreme low water at –4 feet mean lower low water (MLLW) to extreme high water at +14.8 MLLW. Circulation within Elliott Bay is driven principally by tidal forces, modified somewhat by the effects of winds, salinity and temperature differentials.

The area typically has warm dry summers and cool wet winters. July is the warmest month and January the coldest. The mean annual precipitation is about 40 inches, most of it falling as light to moderate rain from October through March. Prevailing winds are from the south or southwest in winter and the west or northwest in summer.

2.2 Historic Conditions

This area at one time was part of the Green/Duwamish River Estuary. Over approximately 100 years the shoreline and intertidal area was filled in until the facility was entirely located on fill material that created the upland.

In 1850, homesteads and settlements appeared in the lower river valley near the Black River, and near present day Tukwila and Kent. By the late 1850's, a steady increase in agriculture practices began to significantly change the ecosystem of the lower valley.

Dredging of the mouth of the estuary and construction of Harbor Island by the City and Port of Seattle began in the early 1900s. Congress funded a navigation project for deepening, widening, and straightening of the estuary portion of the Duwamish River. Dredge materials were placed in the estuary during construction and maintenance of the channel. The Duwamish delta at one time was over 4,000 acres of tidal and intertidal habitat. Only about 1 percent of the estuary remains today. Between the levees, channelization, diversion dams (water source) and construction of dams for flood control in conjunction with the above listed estuary destruction the entire ecosystem in this area has been degraded.

Prior to the filling in of this estuary type habitat, one can speculate based on historical runs of Salmon up the Duwamish and the harvesting of clams along the Elliott Bay Waterfront before Euro-American settlement, there was a sustainable and uncontaminated resource available. This area probably supported populations of bull trout as well, because they are known to have historically existed in the Duwamish River.

2.3 Current Conditions

Uplands surrounding Elliott Bay have been developed for urban, port, and industrial land uses, resulting in the elimination of nearly all intertidal wetlands and shallow aquatic habitats (Tetra Tech 1988). Intertidal habitats that are present in the MSU include mud and sandflats (about 2.3 acres) based on the lowest spring tides. This area also contains bulkheads, pilings, and riprap. The remaining intertidal mud or exposed sand occurs only as a thin strip at the toe of the riprap banks and are only exposed at extremely low tides. Subtidal habitat consists primarily of sandy silts, and muddy and coarse sands, except at the mouth of the Duwamish River, where sandy substrates predominate (Dexter et al. 1981; PTI and Tetra Tech 1988). The MSU is located in a transition zone between the

estuarine environment of the Duwamish River and the marine environment of Elliott Bay; as a result, the substrates and waters adjacent to the site contain habitat characteristics common to both environments.

3.0 DESCRIPTION OF PROPOSED ACTIONS

The Pacific Sound Resources Superfund Site is located in the southern portion of Elliott Bay, south, easterly of Duwamish Head, and northwesterly of the West Waterway, Puget Sound, Washington. The site includes the area where the Wyckoff West Seattle Wood Treating facility existed, contaminated sediments in adjacent Elliott Bay. Pacific Sound Resources, the wood-treating facility was listed on the Superfund National Priorities List (NPL) in May 1994.

The Record of Decision (ROD) (USEPA 1999) identified the following remedial action objectives for cleanup in the marine sediment unit (MSU):

- Minimize human exposure through seafood consumption (to contaminants)
- Minimize benthic community exposure to site contaminants

Attainment of these overall objectives, as specified in the ROD, will be measured by compliance with the State Sediment Management Standards (SMS)(WAC 173-204). The SMS establish a narrative standard with specific biological effect criteria and numerical chemical concentrations for Puget Sound sediment. Under the SMS, the cleanup of a site should result in the elimination of adverse effects on biological resources and any health threats to humans. Capping will cover Cleanup Screening Level (CSL) exceedences for PAHs and Sediment Quality Standards (SQS) exceedences for PSBs; SQS exceedences (for PAHs) exist outside ROD-defined cap boundaries, thus offsite deposition is largely beneficial. The upland portion of this unit was completed in 1998. This clean up consisted of phase one; demolishing the entire wood treatment facility and approximately 4,000 cubic yards (cy) of highly contaminated soil and process sludge were removed from the site. In 1996, phase two consisted of the placement of a subsurface physical containment barrier (slurry wall) to prevent light non-aqueous phase liquid (LNAPL) from migrating into Elliott Bay and to reduce the influence of tidal fluctuation at the site. In addition, a low-permeability asphalt cap was placed over a clean layer of fill placed at the site. The following subsections describe the proposed actions to remediate the subtidal portions of the PSR Superfund Site.

3.1 Marine Sediment Cap

The marine sediment cap will be designed to do the following:

- Reduce the chemical flux from contaminated sediments and groundwater, and chemically isolate these sources from benthic organisms;

- Physically isolate the contaminated sediments and provide a clean habitat for benthic organisms;
- Maintain stability under static loads and have an acceptable reliability under design seismic loads;
- Resist erosion, suspension and transport of cap materials and underlying contaminated sediments by waves, tidal and wind induced currents, and propeller wash.

Confinement of contaminated marine sediments is accomplished by placement of a sediment cap that covers approximately 55 acres. Approximately 66 acres outside the cap boundaries are anticipated to be affected by deposition of cap material. The bulk of this off-site depositional area (approximately 55 acres) is associated with RA5 (Section 3.1.1), and occurs at depths below –150 feet MLLW.

It is understood that site conditions limit the ability to ensure cap stability under extreme seismic conditions especially on slopes. Design documentation will include an Operations Maintenance Monitoring Plan (OMMP) in which procedures associated with cap repair and maintenance will be identified.

The cap design, including cap thickness and material specifications, will be completed in accordance with the Guidance for In Situ Subaqueous Capping of Contaminated Sediments (EPA 905-B96-004). The ROD also specifies the following design parameters for the cap:

- A minimum cap thickness of 5 feet in the intertidal area
- Capping material must be at least as clean or cleaner than the SQS and, according to the ROD, will originate from routine maintenance dredge projects in local rivers when the material is available;
- Capping material will be selected and placed in such a way as to provide appropriate habitat for the marine organisms natural to this area.

Material specifications are included in the design phase. It is necessary to use upland materials for capping certain areas of the site to enhance cap stability and allow for construction activities to be completed within specific time periods, e.g., fish windows.

The ROD also specifies the entire area that is capped be designated a “no-anchor” zone, to prevent damage by commercial vessels using large “whale-tail”-type anchors. Dredging restrictions will be placed on any future work within the PSR-MSU site.

3.1.1 Design at 100% (100% Design Submittal, URS Greiner, 2002)

The ROD specifies the portions of the MSU that require capping and are shown in Figure 3.1. The MSU is divided into the following RA's:

RA1: Intertidal/Shallow Subtidal Area: The RA1 boundaries are defined to extend from the top of the bank, offshore a sufficient distance to construct the required grade transitions to the adjacent offshore RAs. According to the ROD, a minimum 5-foot cap thickness is required for capping contaminated sediments in the intertidal area. (The term "intertidal area" as used in this document includes areas with sediment at existing mudline elevations from –10 feet MLLW to +14.8 feet MLLW, the maximum tidal elevation [Nelson 1978]. Several hundred wooden pilings and associated overhead wooden beams in RA1 will be removed prior to placement of the intertidal cap. In accordance with the ROD, pilings will be cut or broken off at the mudline and if possible some will be removed by vibration. The 5-foot cap thickness is required over existing sediments (and buried piling stubs) within these elevations, but not over existing riprap within these elevations. This definition allows placement of a minimum 5-foot-thick cap to achieve final elevations within the intertidal elevations of –4 feet MLLW to +14.8 feet MLLW. Erosive forces due to surface waves, propeller wash, and cross-shore sediment transport processes determine the particle size of capping material in RA1. Design elements include intertidal habitat enhancement and establishment of beach areas. Engineered features such as specific materials, specific slopes, and riprap slope caps are necessary for physical cap stability in RA1. Due to the complex topography in RA1, significantly different slope profiles are required along various segments of the shoreline.

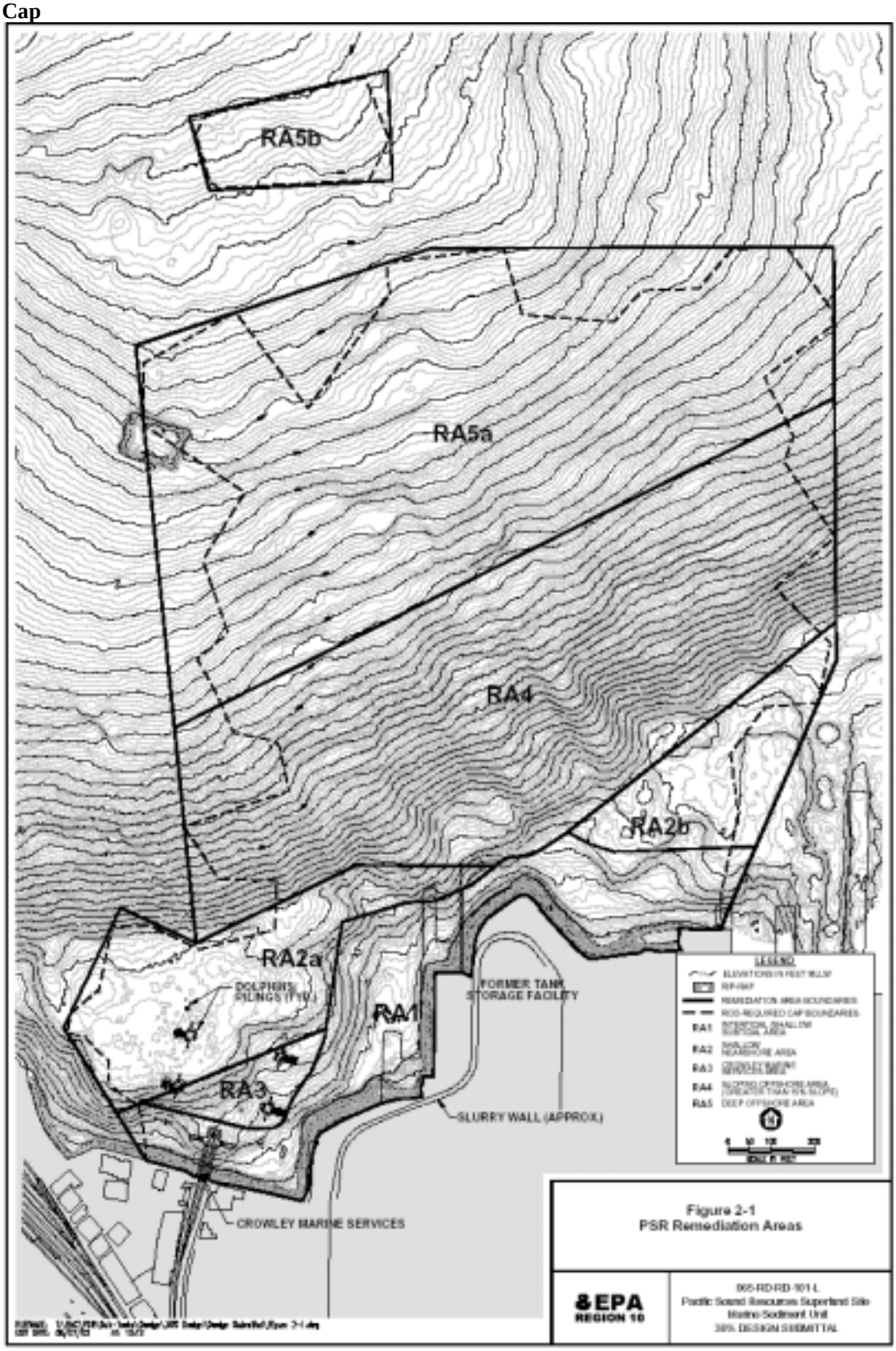
RA2: Shallow Nearshore Area. RA2 consists of two discrete nearshore areas, RA2a and RA2b, which extend from approximately -15 to -50 feet MLLW. RA2a and RA2b are characterized by relatively flat areas or shallow slopes, with localized steepened areas. Conditions in this area are analogous to conditions at other capping projects in the Puget Sound region, such as Eagle Harbor . Erosive forces due to propeller wash determine the particle size of capping material in RA2a. Erosive forces are not anticipated to be significant in RA2b.

RA3: Crowley Marine Services Area. It is necessary to maintain navigational depths in this area for barges, tugs, and other vessels. Because sediment contamination in this area extends to depths of 8 to 10 feet below the mudline and because of the need to maintain navigational access, a cap cannot be constructed in the area of Crowley Marine Services without first removing materials through dredging. The capping material in this area must also resist erosive forces from propeller wash. Section 3.2 discusses in detail the proposed dredging process at Crowley Marine.

RA4: Sloping Offshore Area. This area extends from approximately -50 to -140 feet MLLW and includes relatively steep slopes with approximately 15 percent to 25 percent grades. Stability of these soft/loose sediment slopes and the potential for failure during cap placement requires specific controlled cap placement methods.

RA5: Deep Offshore Areas. RA5 consists of sub-areas RA5a and RA5b. These areas extend from approximately -140 to -240 feet MLLW and include slopes with approximately 4 percent to 15 percent grades. Placement of cap material in RA5 can be accomplished in the most cost-effective manner by instantaneous bottom-dump placement of dredged material from other dredging projects especially federal navigation projects.

Figure 3.1 Sediment Cap



3.2 Dredging near Crowley Marine

Dredging of approximately 10,500 cubic yards of contaminated sediment from the area north of Crowley Marine Services will allow capping while maintaining current navigational depths (Figure 3.1).

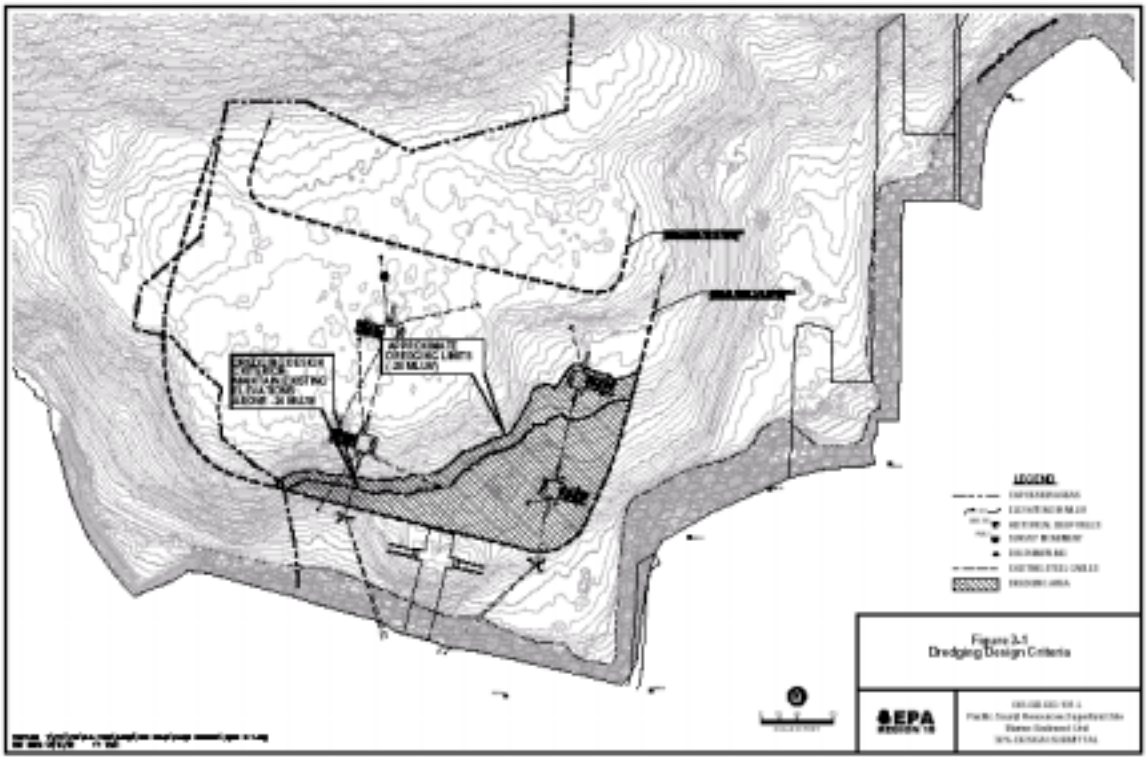
Sediments will be dredged from the Crowley Marine Services Area using mechanical equipment because mechanical equipment is anticipated to be more cost effective and has fewer associated dewatering logistical concerns, compared to hydraulic equipment. Disposal of dredged sediments will be at an established upland solid waste landfill, in accordance with the ROD. Piling or other debris encountered during the remediation will be managed in accordance with the substantive provisions of state regulations (WAC 173-304-200), and will be either recycled or sent to a permitted solid waste facility. In addition, all off-site treatment, storage, and disposal of CERCLA waste will occur at facilities that are acceptable under EPA's Off Site Rule.

The specifications that will follow in the design phase of this proposed project will require the contractor to submit a remedial action work plan that describes the equipment, procedures, materials, methods, disposal location, and personnel to be employed in the work for the landfill and dredging processes. If barges are used for transport of material dredged from Crowley area, they will be subject to requirements for leakage and overflow that are commonly used in sediment remediation.

For planning purposes, the following dewatering, transportation and disposal scheme is envisioned for dredged material:

- Sediments will be mechanically dredged and placed on flat-deck barges on site. Best engineering practices will be used to minimize free draining liquids prior to transport. The sediments will be allowed to dewater by gravity drainage for several hours, and the barges will be equipped with filters for limiting turbidity of overflow.
- After dewatering, the sediments will be loaded into standard 20-foot lined shipping containers (either on site or in Seattle);
- The sediments will be sent by rail to the Roosevelt Landfill in eastern Washington for disposal. Under this landfill's operating permit, sediments disposed of at this landfill do not need to pass the paint filter test for free-draining water (as water content is beneficial to the operation of this landfill). The operation permit does however require the use of best engineering practices to minimize free draining liquids.

Figure 3.2 Dredging Areas



3.3 Removal of unused Piling prior to Capping

Several hundred piling and associated overhead wooden beams will be removed to facilitate placement of the near shore capping system. Piling removal will be conducted by the Port of Seattle to minimize the impact of removal on Port activities and public access to existing park facilities. In accordance with the ROD, piling will be cut off at the mud line and some will be removed by pulling and vibrating. Approximately 800 pilings will be removed from the aquatic habitat. The majority of the pilings and associated overhead timbers are located in the intertidal area, with about one third of the total number located in the shallow subtidal area.

For planning purposes, the following scheme is envisioned for the removal and disposal of timber pilings and the associated overhead timbers:

> The first stage of removal will involve the above-water timbers that form trestle-like structures attached to some of the piling. These creosote-treated timbers will be removed using a barge-mounted crane and/or landside crane (Contractor's option).
>
> After demolition of the superstructure and removal of pile caps and decking, creosote-treated piling will be either pulled, or cut off within 1 foot of the existing ground surface.

Areas where piling must be cut off generally correspond to riprap slopes that also provide a foundation for the concrete plaza and the asphalt environmental cap. In addition, piling will be cut in intertidal areas above elevation 0 feet MLLW if they cannot be accessed for pulling by the Contractor. To the maximum extent possible, pile cutting will occur during dry conditions. Some unforeseen pile cutting may be required in deeper water if the Contractor breaks a piling above the mudline during pulling. A containment boom will be required around the area to keep floatable debris from this operation from drifting to other areas.

In dry areas where the Contractor can reach them from the water, and outside the zone where piling must be cut, piling will be pulled during low tide. In deep water areas where work cannot be performed under dry conditions, piling will be pulled during any tide stage. Attaching a vibratory hammer to the top of the piling will pull piling. With the vibrator engaged, the Contractor will begin to pull the piling. Once upward movement begins, the vibrator will be turned off, and the piling will be removed in a continuous motion.

Timbers and piling removed from their current location will be stacked on a barge staging area. Any sediment brought up onto the barge staging area, as part of the piling removal will be contained. Any collected sediments will be returned to the general area from which it was removed. In order to avoid or minimize the potential for an oily sheen from occurring (from sediment disturbance), the sediments will be returned to the mudline using a rehandling bucket or dredge that is relatively watertight. Small loads of sediment will be released at the mudline to reduce the chance for the disturbance.

Conservation Measures and BMPs will be implemented throughout each phase of this work.

Piling removal needs to be completed prior to capping.

3.4 Anchoring of Boats

Implementation of institutional controls that restrict the use of boat anchors and place specific requirements on any future dredging in the capped area must be provided by the sponsor (EPA).

3.5 Monitoring Plan

Development and implementation of both a short and long-term monitoring and management plan to ensure that the cap is placed as intended and is performing the basic confinement functions. The Corps will develop the monitoring plan and it will be in place prior to start of construction.

4.0 BIOLOGICAL RESOURCES

Biota utilizing habitat within the MSU includes a variety of marine invertebrates, estuarine and marine fishes, salmonids (anadromous), birds, and marine mammals.

Common marine invertebrates on the piling surfaces, riprap, and bulkhead areas of the MSU include barnacles, tube-dwelling worms, sea anemones, sponges, tunicates, and mussels. Marine invertebrates documented or anticipated to utilize the offshore subtidal habitat of the MSU include a variety of polychaetes, clams, mussels, crab, and shrimp.

Habitats within the MSU provide nesting and adult forage areas on either a seasonal or year-round basis for numerous estuarine and marine species of fish that are found in Elliott Bay, including Pacific herring (*Clupea harengus*), shiner perch (*Cymatogaster aggregata*), snake prickleback (*Lumpenus sagitta*), Pacific tomcod (*Microgadus proximus*), pile perch (*Rhacochilus vacca*), Pacific sand lance, copper rockfish, Pacific staghorn sculpin, and various flatfish species, most notably English sole (Tetra Tech 1988; Dexter et al. 1981). The most abundant fish species collected during the remedial investigation fish trawling activities included English and slender sole, Pacific hake, and Pacific tomcod.

Salmonids represent the most important anadromous fish present in the vicinity of the MSU. Chinook, pink, and chum salmon are common, while coho and sockeye salmon, steelhead trout, bull trout, and cutthroat trout are less abundant. Multiple migratory runs of both native and hatchery reared salmonid stocks occur seasonally in Elliott Bay and Duwamish River (Warner and Fritz 1995). Returning adult salmon congregate at the mouth of the Duwamish River in the vicinity of the MSU prior to upstream migration, and juvenile salmonids may use the nearshore reaches of the MSU for transition to marine waters.

Shorelines of and waters overlying the MSU provide habitat to a number of terrestrial and water dependent birds, including loons, grebes, cormorants, scaups, mergansers, scoters, coots, and gulls. The majority of these birds utilize the water column habitat in the vicinity of the MSU during their respective over wintering periods. Two state monitor species, the osprey and great blue heron, breed close to and possibly feed on fish within the MSU. However, the great blue heron utilizes primarily shallow water habitats that can be accessed by wading or perching on structures immediately next to or floating on the surface. This type of habitat is extremely limited at the site and in some cases exists only under pier structures. In addition, two other state monitor species (the horned grebe and red-necked grebe), as well as five state candidate species (the western grebe, Brandt's cormorant, merlin, common murre, and Cassin's auklet), and two state sensitive species (the peregrine falcon and common loon) are also likely to forage or utilize surface waters associated with the MSU. The bald eagle (a state and federally listed species) and the peregrine falcon have also been observed in the vicinity of the MSU. The bald eagle may feed on fish occurring in the water column. However, the peregrine falcon feeds primarily on other birds. Occurrence of these prey species at the site is habitat-limited, thus exposure of the peregrine to site-related contaminants is unlikely. The marbled murrelet (state and federally threatened) depends on nesting in old growth and feeding in

coastal marine environments. The murrelet is more common in northern Puget Sound. Other species that winter in Puget Sound and may be present in the project area include the brown pelican (state and federally endangered) and the harlequin duck (federal species of concern).

Marine mammals known to frequently forage in Elliott Bay include harbor seals and California sea lions. The harbor porpoise (historically common in south Puget Sound) is also seen infrequently and is a state candidate species. Harbor porpoise and harbor seals are year-round residents, while California sea lions utilize the area for winter feeding (Pfeifer 1991). Both the harbor seal and California sea lion are state monitor species and have been observed hauled out on floating structures near the site.

4.1 Anadromous Species

Salmonids are the most important anadromous fish present in the vicinity of the MSU. Chinook (*Onchoryhnchus tshawytscha*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon are common, while coho (*O. kisutch*) and sockeye (*O. nerka*) salmon, steelhead trout (*O. mykiss*), and cutthroat trout (*O. clarki*) are less abundant. Chinook, chum, and coho, and steelhead trout utilize Elliott bay to access upstream freshwater spawning habitat associated with the Duwamish and Green rivers. Chinook and chum utilize Elliott Bay and the Duwamish estuary more extensively than other anadromous species (Weitkamp and Schadt 1982; Meyer et al. 1981), especially when congregating at the mouth of the Duwamish River (vicinity of the MSU) during their adult return.

Multiple migratory runs of both native and hatchery-reared salmonid stocks occur seasonally in Elliott Bay and the Duwamish River (Warner and Fritz 1995). Summer and fall chinook, coho, chum, and sockeye salmon, summer and fall steelhead, and cutthroat trout runs occur between late June and early December. Runs of spring chinook and steelhead are known to occur between January and late May.

Following their emergence from spawning gravels and downstream migration, juvenile salmon use this estuarine zone to acclimate to saline water conditions. Additionally, these habitats provide feeding areas essential for juvenile chinook and chum salmon (Warner and Fritz 1995; Williams et al. 1975). The residence time of juvenile chinook in the lower Duwamish estuary can last up to 16 or more weeks with peak densities occurring in late May (Simenstad et al. 1982). The juvenile chinook, chum, and pink salmon have been observed in varying abundance and within 0.5 km of the MSU (Weitkamp and Schadt 1982).

Table 4.1 Fish Species That May Occur Within the Project Vicinity

Common Name	Scientific Name	Status State	UFWS	NMFS	EFH
Pacific Sound chinook	*Oncorhynchus tshawytscha*	C	None	T	H
Bull trout	*Salvelinus confluentus*	C	T	None	
Pacific cod	*Gadus macrocephalus*	C	None	None	H
Pacific hake	*Merluccius productus*	C	None	C	H
Walleye Pollock	*Theragra chalcogramma*	C	None	None	
Brown rockfish	*Sebastes auriculatus*	C	None	None	H
Copper rockfish	*Sebastes caurinus*	C	None	None	H
Greenstriped rockfish	*Sebastes elongatus*	C	None	None	H
Widow rockfish	*Sebastes entomelas*	C	None	None	
Yellowtail rockfish	*Sebastes flavidus*	C	None	None	H
Quillback rockfish	*Sebastes maliger*	C	None	None	H
Black rockfish	*Sebastes melanops*	C	None	None	
China rockfish	*Sebastes nebulosus*	C	None	None	H
Tiger rockfish	*Sebastes nigrocinctus*	C	None	None	H
Bocaccio rockfish	*Sebastes paucispinis*	C	None	None	
Canary rockfish	*Sebastes pinniger*	C	None	None	H
Redstripe rockfish	*Sebastes proriger*	C	None	None	H
Yelloweye rockfish	*Sebastes ruberrimus*	C	None	None	H
Pacific Sound-Straight of Georgia coho salmon	*Oncorhynchus kisutch*	None	None	C	H
Pacific lamprey	*Entosphenus tridentatus*	None	None	SoC	

Leatherback sea turtle	*Dermochelys coriacea*	E	None	E	

Source: WDFW Explanation of Status Codes: C= Candidate for listing as threatened or endangered; E= Endangered, M= Monitor; S= Sensitive; SoC= Species of concern and T= Threatened

4.2 Marine Invertebrates

Most of the intertidal habitat is characterized by pilings supporting piers, bulkheads, and steeply sloped riprap along the shoreline. Common inhabitants of piling surfaces include barnacles, sea anemones, sponges, tunicates, and mussels (Parametrix 1994).

Most of the nearshore habitat of the MSU consists of steeply sloped riprap and bulkheads. Marine invertebrates such as barnacles, tube dwelling worms, and mussels prefer that type of hard substrate. Some algae, such as *Fucus distichus* (Brown algae), *Enteromorpha intestinalis* (Gut weed), and *Ulca lactuca* (Marshy plant) are also found colonizing in these areas contributing to the complexity of the biological community.

The offshore subtidal habitat within the MSU consists of soft sand and mud substrates. These areas are generally inhabited by assemblages of benthic infauna, with species composition and densities largely representative of the general central Puget Sound and Elliott Bay. Also several molluscan species have been reported to reside year-round in Elliott Bay. Species most abundant are Pacific littleneck (*Protothaca staminea*), butter (*Saxidomus giganteus*), geoduck (*Panope generosa*), bent-nosed (*Macoma nasuta*), heart cockle (*Clinocardium nuttallii*), gaper (*Tresus capax*) and soft-shell clam (*Mya arenaria*) (Scholz 1991; Schink et al. 1983; Dexter et al. 1981). The most common species found in Elliott Bay is the bent nosed clam (Dexter et al. 1981).

Dungeness (*Cancer magister*) and red rock (*C. productus*) crab are found throughout Elliott Bay, but are less abundant than in other estuaries of Puget Sound (Wood 1991). Both species trend to congregate near intertidal and subtidal flats (Johnston 1991). Nearshore habitats of the Duwamish River estuary may have concentrations of Dungeness crab (Wood 1991; WDNR 1977); however, only red rock crab were encountered during the September 1996 reconnaissance survey conducted for the Remedial Investigation (RI).

Three species of shrimp; spot (*Pansalus platyceros*), crangon shrimp (*Paracarangon echinata*), and dock (*Pandalus danae*) shrimp, regularly drift into Elliott Bay from Puget Sound. Spot shrimp are reported to be the most abundant species in Elliott Bay, but do not occur in sufficient numbers to support a commercial fishery. There is an active recreational fishery for shrimp in some areas of Elliott Bay, including barge moorage area at the perimeter of the MSU.

During the RI, 15 different invertebrate species were collected during the

reconnaissance survey and the bioaccumulation study in waters extending from 30 to 60 meters in depth (Table 4.2).

Table 4.2 Invertebrate Species Collected in the MSU[U]

Common Name	Scientific Name
Sea star	*Hippasteria spinosa*
Sea star	*Luidia foliolata*
Sea star	*Evasteria troschelii*
Blood star	*Henricia leviuscula*
Sun star	*Solaster dawsoni*
Vermillion star	*Mediaster aequalis*
Sea cucumber	*Stichopus californicus*
Sea cucumber	*Cucumaria piperata*
Alaskan pink shrimp	*Pandalus eous*
Spot shrimp	*Pandalus platyceros*
Crangon shrimp	*Crangon spp.*
Octopus	*Octopus rubescens*
Benthic squid	*Roscia spp.*
Snail	*Ceratostoma foliatum*
Nudibranch	*Armina californica*

[U] Appendix K, Technical Memorandum, Roy F. Weston, Inc. 1998.

4.3 Marine Mammals

Harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), killer whale (*Orcinus orca*), gray whale (*Eschirichtius robustus*), Dall's porpoise (*Phocoenidae*) and harbor porpoise (*Phocoena phocoena*) are know to frequently forage in Elliott Bay (Calambokidas 1991). Harbor porpoise and harbor seals are year-round residents. Sea lions may utilize waters of the MSU in the winter to feed on migrating salmon and steelhead trout (Pfeifer 1991). Both species have been seen hauled out on floats and navigation buoys moored within the MSU.

Steller sea lion (*Eumetipias jubatus*) and humpback whale (*Megaptera novaeangliae*) are the only marine mammal species potentially within the PSR-MSU action area that are federally proposed or listed as threatened or endangered species.

4.4 Birds

Shorelines of and waters overlying the MSU may provide habitat to a number of water-dependant birds (Table 4.3). The majority of these waterfowl potentially utilize habitats in the vicinity of the MSU during their respective over wintering periods. These over wintering waterfowl species are generally found in the central Puget Sound region from early November through late April, with the highest concentrations during December through February. The remaining waterfowl are present year-round.

General prey assemblages for these birds are provided in Table 4.2 and include a wide variety of small fishes, crustaceans (e.g. amphipods, crab), mollusks (clans, mussels, snails), and polychaete worms. Most of the year-round and over wintering species are classified as "divers" and actively pursue pelagic and benthic organisms up to 10 meters or more below the water surface.

Table 4.3 Avian Species Expected to Inhabit the Marine Sediment Unit

Common Name	Scientific Name	Seasonality[a]	Primary Winter Food
Common loon	***Gavia immer***	W	Fish
Yellow-billed loon	*Gavia adamsii*	W	Fish
Pacific loon	*Gacia pacifica*	W	Fish
Red-throated loon	*Gavia stellata*	W	Fish
Western grebe	*Aechmophorus occidentalis*	W	Fish, aquatic insects
Red-necked grebe	*Podiceps grisegena*	W	Aquatic insects, invertebrates, fish
Horned grebe	*Podiceps auritus*	W	Fish, crustaceans
Eared grebe	*Podiceps nigricollis*	W	Aquatic insects, larvae, fish
Pied-billed grebe	*Podilymbus podiceps*	Y	Aquatic insects, invertebrates
Double-crested cormorant	*Phalacrocorax auritus*	Y	Fish
Brandt's cormorant	*Phalacrocorax penicillatus*	Y	Fish
Pelagic cormorant	*Phalacrocorax pelagicus*	W	Fish
Great blue heron	*Ardea herodias*	Y	Fish, amphibians, etc
Greater scaup	*Aythya marila*	W	Mollusks, etc
Lesser scaup	*Aythya affinis*	W	Mollusks, amphibians,
Black scoter	*Melanitta nigra*	W	Mollusks, crustaceans
White-winged scoter	*Melanitta fusca*	W	Crustaceans, mollusks
Surf scoter	*Melanitta perspicillata*	W	Mollusks, crustaceans
Common goldeneye	*Bucephala clangula*	W	Crustaceans, mollusks
Bufflehead	*Bucephala albeola*	W	Fish, aquatic insects, vegetation
Common merganser	*Mergus merganser*	W	Fish
Red-breasted merganser	*Mergus serrator*	W	Fish
Hooded merganser	*Lophodytes cucullatus*	Y	Fish
American coot	*Fulica Americana*	Y	Aquatic vegetation, algae, etc
Herring gull	*Larus argentatus*	W	Scavenges, omnivore
Glaucous-winged gull	*Larus glaucescens*	Y	Mollusks, fish, scavenges
California gull	*Larus californicus*	W	Invertebrates, fish scavenges
Western gull	*Larus occidentalis*	Y	Aquatic invertebrates
Bonaparte's gull	*Larus Philadelphia*	W	Fish, insects, scavenges
Ring-billed gull	*Larus delawarensis*	W	Fish, insects, scavenges
Mew gull	*Larus canus*	W	Fish, insects, scavenges
Pigeon guillemot	*Cepphus Columba*	Y	Crustaceans, mollusks
Rhinoceros auklet	*Cerorhinca monocerata*	W	Crustaceans, fish
Bald eagle	*Haliaeetus leucocephalus*	Y	Fish, sm.mammals, seabirds, carrion
Belted kingfisher	*Ceryle alcyon*	Y	Fish
American crow	*Corvusbrachyrhynchos*	Y	omnivore

[a] Washington Department of Fish and Wildlife. Period during which species is expected to be found at the PSR site: W= winter, Y= year-round

5.0 Biological Requirements of Federally Listed or Proposed Threatened or Endangered Species

The following sections will focus on the two listed salmonid species because of the complex nature of their habitat and life cycle requirements. The other listed species in the action area are discussed in detail in Section 13.

5.1 Puget Sound Chinook Salmon *(Oncorhynchus tshawytscha)*

Chinook salmon are the largest of the Pacific salmon with individuals over 120 pounds recorded. Like all Pacific salmon, chinook reproduce in fresh water but spend the majority of their life cycle in the marine environment. Chinook remain at sea an average of 2 to 4 years before returning to their natal stream to spawn. Chinook are generally classified either as ocean or stream type. Ocean-type fish are characterized by a short juvenile freshwater residence time and normally migrate to estuarine areas within their first year (usually around three months after emergence from spawning gravel). They typically return to their natal stream a few days or weeks before spawning. Stream-type chinook typically spend one or more years in fresh water before migrating to the sea and often return to their natal streams several months prior to spawning. The majority of Puget Sound chinook salmon including those that may use PSR-MSU are ocean-type, which migrate out as sub-yearlings.

Estuaries are an important rearing habitat for all species of salmon, but chinook are probably the most dependent on this type of habitat (Healy 1982). Salmon use estuaries for rearing, refuge from predators, and as a physiological transition area (Simenstad et al 1982). Rapid growth also occurs in estuaries due to the abundance of preferred prey. Rivers with well-developed estuaries are generally able to sustain larger ocean-type populations than those without. Juvenile chinook rear in estuaries for a period of days to two months. They range in size from 35 to 160 mm in length when entering the estuary (Beauchamp et al 1983). Ocean-type chinook are usually smaller and tend to utilize estuaries and coastal areas more extensively for rearing than stream-type juveniles (Healey 1991).

EPA chose to rely on the State records for out-migration for Puget Sound that indicate the majority of the juvenile fish move out of their natal streams and into the estuary between early march and mid- to late summer (WDFW 1995). EPA still assumed some use of the harbor by juvenile migrants, likely after their earliest exiting period from the natal streams. EPA conservatively chose the dates between February 15th and August 15th to represent the periods of juvenile chinook use of Elliott Bay for planning construction activities. However, dates are pending further consultation with the resource agencies.

5.2 Bull Trout (Salvelinus confluentus)

The status and occurrence of anadromous populations of bull trout in Puget Sound are subject to some scientific debate. Separating anadromous bull trout from the closely related anadromous Dolly Varden char (*S. malma*) is very difficult and can only be accomplished using electrophoretic techniques (Leary and Allendorf 1997). Until further resolution is possible, WDFW has made a decision to manage all Puget Sound stocks as if they were a single bull trout/Dolly Varden complex (Washington Department of Wildlife [WDW, now WDFW] 1993).

Two distinct life-history forms, migratory and resident, occur throughout the range of bull trout (Pratt 1992, Rieman and McIntyre 1993). Migratory forms rear in natal tributaries before moving to larger rivers (fluvial form) or lakes (adfluvial form) or the ocean (anadromous) to mature. Migratory bull trout may use a wide range of habitats ranging from second- and sixth-order streams and varying by season and life stage. Seasonal movements may range up to 190 miles as migratory fish move from spawning and rearing areas into overwintering habitat in downstream reaches of large basins (Bjornn and Mallet 1964). The resident form may be restricted to headwater streams throughout life. Both forms are believed to exist together in some areas, but migratory fish may dominate populations where corridors and subadult rearing areas are in good condition (Rieman and McIntyre 1993).

Bull trout appear to have more specific habitat requirements than most other salmonids (Reiman and McIntyre 1993). Habitat characteristics, including water temperature, substrate composition, cover, stream size and hydraulic complexity, have been associated with distribution and abundance (Dambacher et al 1992; Jakober 1995; Rieman and McIntyre 1993).

Bull trout spawn from August through November (McPhail and Murray 1979; Pratt 1992); however, migratory bull trout frequently begin spawning migrations as early as April (USFWS 1998a). Bull trout incubation period is long (4 to 5 months) compared with other salmon and trout. Fry hatch in late winter or early spring and remain in the gravel for up to 3 weeks before emerging. A few weeks after emerging, some bull trout migrate to salt water, while the remainder stay in the streams where they hatched (USFWS 1998b). Growth, maturation, and longevity vary with environment; first spawning is often noted after age four, with individuals living 10 or more years (Rieman and McIntyr 1993).

Small bull trout eat terrestrial and aquatic insects. Large bull trout are primarily fish predators, eating whitefish, sculpins, juvenile salmon, and other trout (USFWS 1998a). Bull trout and chinook salmon feed primarily on pelagic organisms; bull trout are less dependent on nearshore habitat than chinook (Tacoma 1998).

Bull trout may occur in the project area, however, there are no records or studies that indicate their presence and/or abundance in Elliott Bay. Assuming that bull trout will be present in the area during chinook migration, EPA adopted the same

approximate time period for chinook presence to represent bull trout presence for construction activity planning.

6.0 Base Line Conditions for the MSU

This section describes habitat indicators important for salmonids in the estuarine environment. Estuarine habitat is emphasized because of the potential effects of the proposed action on this type of habitat. For non-salmonid threatened and endangered species in the action area, EPA used a more narrative approach (see Section 13). The complexities of salmonid life histories and estuarine use warranted a more structured approach for the assessment of effects.

EPA adopted methodology presented in a biological assessment prepared by the U.S. Navy at Bremerton, Washington (1999), which was based on concepts developed by NMFS for salmon habitat in streams (NFMS 1999c). The methodology was modified to be suitable for evaluating effects in the MSU. The methodology provides indicator-based categories of habitat function developed from review of the scientific literature and best professional judgment. Where possible, EPA provided quantitative data; however, some qualitative analysis was unavoidable.

The indicators form the matrix of pathways used to establish an environmental baseline for the project and determine the effects of the proposed actions. The estuarine matrix is divided into three major pathways that address water quality, estuarine habitat quality, and biological habitat quality. EPA used the extant literature and best professional judgment to develop indicators for each factor. EPA either selected or developed indicators pertinent to estuarine systems. The pathways and indicators are described in the following paragraphs.

6.1 Water Quality – Turbidity

Although there are limited studies on the effects of turbidity specific to salmon in the estuary, some studies suggest that both wild and hatchery fish exhibit avoidance behavior in response to increases in turbidity. In laboratory tests, Martin et al (1977) found that juvenile chum exhibited avoidance behavior in all test concentrations, and that toxicity was primarily a function of suspended sediment composition (particle size and shape) and fish condition. Healthy fish were able to tolerate very high concentrations (up to 3056 mg/L), while “fish infected by vibriosis and/or furunculosis (had) a very low tolerance to suspended sediment.”

Adverse effects may occur when juvenile salmonids are unable to avoid high, extended periods of turbidity. Lethal suspended sediment concentrations occur at 1100 mg/L for chinook salmon (Beauchamp et al 1983). Turbidity can also play a role in both salmon migration and feeding behavior. Adult salmon cease upstream movement in streams when total suspended solids (TSS) exceed 4000 mg/L (Healey 1991, Beauchamp et al 1983). Laboratory studies with coho salmon found that feeding stops when TSS concentrations reach 300 mg/L (Sandercock 1991). This level was the lowest value for

turbidity that was reported to cause adverse effects. Preferred TSS levels for coho in streams are reported to be less than 25 mg/L (Laufle et al 1986).

While it is clear that juvenile fish will exhibit avoidance behavior in high turbidity levels, toxic effects might occur when fish are unable to avoid high turbidity and if the turbid conditions occur over an extended period of time. Adverse effects from high turbidity are also more likely when juvenile salmon have been subjected to repeated environmental stresses that weaken their overall health and viability.

In summary, juvenile salmonids subjected to periodic fluctuations in turbidity are likely to either avoid or tolerate short-term conditions. Turbidity may also provide periodic "refuge" when other available habitat is limited. However, long term high turbidity events (either from catastrophic occurrences or anthropogenic disruptions of natural fluvial processes) are likely to result in harm to juvenile salmon, especially if the fish have been stressed either through disease or other environmental stresses[·]

6.1.1 Existing Conditions – Turbidity

There are no known studies of turbidity within the PSR-MSU. However, there has been a least one study of sediment dynamics that indicates that there are no conditions that will result in high turbidity. The Duwamish could possibly deliver a large sediment load but there is a marginal chance this would reach the PSR-MSU. The many bulkheads and piers that align the Duwamish and adjacent shorelines cause the adjacent shorelines to be sediment starved throughout the action area. The highest source of turbidity in the MSU is likely periodic pulses of sediments from rainfall events and minor pulses from prop-wash at the Crowley Marine facility. There are no data indicating that these conditions result in turbidity levels significantly beyond background conditions.

6.2 Water Quality – Dissolved Oxygen

Low dissolved oxygen (DO) concentrations result when organic material is decomposed (oxidized) in waters that do not mix to the surface where aeration with atmospheric oxygen can occur. Up-welled deep waters and deep waters with overlying organic production can have naturally low DO concentrations. Human input of nutrients that stimulate organic production can drive naturally low DO concentrations to even lower values. Depressed levels of DO available in the water column can have a serious impact on marine organisms. Effects of DO depletion are both organism- and habitat-specific (Harding et al 1992). The degree of impact is dependent upon the temporal and spatial stability of the depressed DO levels. DO concentrations in the water column may not reflect DO concentrations experienced by benthic organisms. Jorgensen (1980) found

[·] Almost all of the literature is base on effects in streams and not open water areas.

that significant DO gradients can exist between 0.5 to 0.05 m above the sediment in a fjord.

Hypoxia, meaning low oxygen, is generally regarded as a DO concentration that is harmful to many organisms. The literature commonly defines hypoxia as occurring at concentrations between 0.5-3.0 mg/L (e.g., Harding et al, 1992; PSEP 1992) or between 0.2-2.0 mg/L (e.g. Pihl et al 1992; Llanso 1992). However, there is evidence that the behavior of some organisms (e.g., fish, larvae) can be negatively affected at DO concentrations as high as 4- to 4.5 mg/L (Whitmore et al 1960, Breitburg et al 1994). The DO concentration of 5 mg/L is typically regarded as the upper limit for "biological stress" induced by low DO (NOAA 1998). Many of the studies of the effects of DO are for freshwater environments, however, the Puget Sound ambient monitoring program uses the same level to indicate stress in marine environments (WDOE 1998).

All salmonids require high levels of dissolved oxygen (DO) to maintain normal physiological function (Spence et al 1996). Bjorn et al (1991) reviewed a number of papers and concluded that while thresholds for survival are generally low (3.3 mg/L), growth and food conversion efficiency are affected at DO levels of 5 mg/L. They determined that DO levels of 8 to 9 mg/L or more are needed to ensure that normal physiological functions of salmonids are not impaired.

Davis et al (1963) and Dahlberg et al (1968) showed that maximum sustained swimming performance dropped for coho and chinook salmon when DO concentrations decreased much below air-saturation levels (8-9 mg/L at 20° C). Alabaster et al (1979) concluded that growth rate and food-conversion efficiency were probably limited if DO concentrations fell below 5 mg/L for Atlantic salmon. Davis (1975) estimated that salmonids would suffer no impairment if DO concentrations remained near 8 mg/L and determined that DO deprivation would begin at approximately 6 mg/L. High water temperatures, which decrease oxygen solubility, further increase the stress on fish caused by low DO concentrations.

Studies with steelhead and sockeye salmon demonstrated initial distress symptoms at 6.0 mg/L and adverse effects at 4.25 mg/L (Reiser and Bjornn 1979). Below 4.0 mg/L coho salmon growth declined. Studies with juvenile chinook indicated marked avoidance occurs at concentrations less than 4.5 mg/L with no avoidance at 6 mg/L (Beauchamp et al 1983).

Bull trout require near saturation level conditions because of their high activity levels. They generally will move away from areas where DO is below 8 mg/L (McCauley 1991). Bull trout are opportunistic feeders and will move into and out of areas with DO below 8, but only if there is a food source that is significant enough to offset a reduction in activity from lack of available oxygen. They generally will not stay in low DO environments.

These studies suggest that 4 mg/L is the value below which adverse effects to salmonids are likely to occur, and NOAA defines 5 mg/L as the upper limit of biological stress. Other studies indicate that bull trout, especially adults, are more sensitive to DO.

6.2.1 Existing Conditions – Dissolved Oxygen

PSR is located in the glaciated trough of Puget Sound. Puget Sound naturally stratifies as the dense, cold ocean water periodically pushes into the Sound. It is likely that even prior to euro-American settlement that portions of the Sound suffered from seasonally reduced DO conditions, especially in the southern reaches.

Under current conditions, PSR-MSU likely follows the patterns of similar bays in Puget Sound. Colder, dense marine waters typically move into the shallow bays under certain tidal or current conditions and then stagnate for a certain period (dependent upon conditions within the bay) until another water mass moves in. During these stagnation periods, DO typically decreases at rates dependent upon sediment oxygen demand, temperature, fresh water influx, and other conditions. Although the Department of Ecology does not identify this area as being a persistently stratified estuary, it is likely that the area does experience decreased DO with depth and during the summer months. EPA evaluated DO conditions at some of the nearest water quality sampling stations[1] for the Department of Ecology's Ambient Water Quality Monitoring program (WDOE Web page, Conditions and Trends). All the stations show at least typical stratification conditions in Puget Sound, with some readings below 5 mg/L at the sediment surface during the summer and early fall months. Generally, water column surface readings stayed above 7 mg/L during the same times.

The DO conditions in the PSR-MSU are partially natural conditions to which the salmon and bull trout populations have adapted; they have likely adapted to avoid low seasonal DO conditions. However, the PSR-MSU is an industrialized bay and any number of controlled or uncontrolled discharges may exacerbate the water quality conditions that might extend or increase the severity of low DO concentrations and that might affect the nearshore environment. Both fish species will generally avoid low DO areas. Consequently, if low DO conditions persist or occur at times when these species are present, it would decrease access to the available feeding and refuge areas.

6.3 Water Quality – Contamination

The State of Washington has established water quality criteria (WQC) for the protection of aquatic life. For the purposes of this BA, EPA has adopted these WQC for determining the presence of chemical contamination and thus a degraded habitat. EPA determined that multiple WQC exceedances or the presence of waters listed as degraded under Section 303 (d) of the Clean Water Act indicated degraded habitat.

[1] The nearest sampling stations are at Elliott Bay (ELB015) which is immediately east of PSR-MSU.

6.3.1 Existing Conditions – Water Contamination

PSR-MSU has multiple exceedances on the 303(d) list for water quality. However, all of the exceedances are due to sediment bound contaminants. Indicators of quality of the water column, such as dissolved oxygen, turbidity, and fecal coliform, have no exceedances. Although there has been no water quality sampling associated with the water column environment within PSR-MSU, Ecology has been studying the effects of contaminated sediments on water quality within the water column. For example, Ecology monitored both the water column and sediment traps to monitor pollutants attached to suspended particulates in the water column in several waterways of Commencement Bay. Ecology determined that water quality continues to be degraded by contaminant exposure due to the re-suspension of contaminated bottom sediments. As such, Ecology believes that Commencement Bay will not be able to meet water quality conditions until the contaminated sediments have been remediated. The same condition is likely true for PSR-MSU; water quality will continue to be degraded until contaminated sediments are isolated from the aquatic environment.

6.4 Water Quality – Sediment Quality

Industrialized estuaries often receive inputs of potentially toxic substances from a variety of anthropogenic sources. Many of these substances accumulate in sediments (Dexter et al 1981). Because juvenile salmon undergo numerous physiological adaptations during their residence in the estuary, direct or indirect exposure to sediment contamination may be injurious. The level of biological dysfunction of a population of salmon has not been directly linked to a specific level of sediment contamination (Varanasi et al 1993). However, Collier et al (1997) showed that contaminant concentrations found in chum and chinook juveniles in the Hylebos Waterway were similar to that measured in juvenile salmon from the Duwamish River. The Duwamish is also a contaminated estuary (Varanasi et al 1993, Arkoosh et al 1991, Arkoosh et al 1996). The Duwamish River study found impaired growth, suppression of immune function, and increased mortality following pathogen exposure in chinook salmon. EPA interprets this information as evidence that juvenile fish experience harm from chemical contamination in industrialized estuaries.

Bull trout greater that 12 inches in size eat smaller nearshore fish almost exclusively. This may pose even a greater problem if they feed on fish that are contaminated. If they are not eating fish, adult and juvenile bull trout are benthic foragers, which may also expose them to another source of sediment contamination.

Although not specifically based on harm to salmonids, the Washington State Sediment Management Standards (SMS) define sediment quality criteria that are used to identify marine sediments having no adverse effects on biological resources. The standards contain both chemical and biological criteria. Since the biological criteria are considered a direct measure of injury to biota, they take precedence. That is, failure of a biological effects test indicates failure to meet sediment quality criteria.

The SMS consist of two levels of standards, the sediment quality standards (SQS) and the cleanup screening levels or minimum cleanup levels (CSL or MCUL). Areas that exceed the CSL are considered to require cleanup. Contamination at lower levels (but above the SQS) can also be included in cleanup decisions depending on the resources to be protected and the costs compared to environmental benefits.

For the purpose of this BA, the SQSs (either chemical or biological) were used to indicate sediment quality. EPA considered sediment with chemical concentrations above the SQS that will not naturally recover as degraded habitats.

6.4.1 Existing Conditions – Sediment Quality

The high degree of sediment contamination currently found in the PSR-MSU, is a product of very recent history, to which local fish populations have probably not adapted. There are probably some background conditions of naturally occurring contaminants; however, most of the chemical pollutants can be traced back to relatively recent anthropogenic sources.

Sediments in the PSR-MSU are contaminated with polycyclic aromatic hydrocarbons (PAH) and other hazardous substances. They far exceed SQS and CSL standards for marine sediments.

6.5 Estuarine Habitat Quality – Estuarine Habitat Area, Diversity, and Accessibility

Estuaries provide the opportunity for juvenile salmonid physiological adaptation from fresh to saline environments and also provide refuge from predators. These areas typically produce an array of food organisms favored by salmonid species of various life history types and sizes during estuarine migration. Shallow fresh, salt and brackish marshes and mudflats are notable for a high production of dipterans (flies) that are characteristic of salmon diets prior to entering more euryhaline habitats (Levy and Northcote 1982, Simenstad and Cordell in press). Within more euryhaline marshes and mudflats, benthic and epibenthic crustaceans become more important prey of juvenile salmon. Preferred prey species are found in areas of marsh vegetation, fine sediments, and tide channels. Within the more saline bay areas, intertidal and shallow subtidal eelgrass and macroalgae beds support additional food sources for salmon fry still limited to shallow-water habitats (Simenstad et al 1991).

Salt and tidal freshwater marshes also provide important rearing habitat for juvenile chinook. Simenstad et al (1982) found that juvenile chinook, especially sub-yearlings, would concentrate in salt marshes when a salt marsh was part of the habitat complex. Bull trout also use tidal channels if they are deep enough to allow access by larger fish. It

can be also important for bull trout if the tidal channels are in relative proximity to the freshwater lens. Studies in Vancouver Island and the Fraser River estuary found chinook smolts made extensive use of the tidal marshes (Healey 1991).

Aquatic vegetation is part of the estuarine complex and can provide extremely important feeding and refuge areas for juvenile salmonids, especially during the spring months when primary production begins to escalate. Examination of stomach content of migrating juveniles in areas of extensive eelgrass show that they feed almost exclusively on organisms that are only found on eelgrass (i.e., harpacticoid copepods colonizing eelgrass blades). Researchers have also noted that juveniles will also stay along the edges of eelgrass beds and retreat to the centers, which suggests that they are also using these systems for refugia. Because eelgrass is important for juvenile salmonids, it is also important for bull trout because juveniles provide an important prey source (Goetz pers. comm.).

Although the relationship is not clearly known, it appears that macroalgae and eelgrass also provide a source to the detritus food chain. Juvenile salmonids may also use dense kelp beds as areas of refuge.

Bull trout, generally benefit from diverse intertidal habitats because they support an abundance of prey species. Where they have been observed in an estuary is usually near the freshwater lens. Both adults and juveniles benefit from large, diverse estuaries with an abundance of tributaries and tidal channels.

6.5.1 Existing Conditions - Estuarine Habitat -

Although PSR-MSU is not an estuary in the sense that there is no large source of freshwater input, the intertidal areas of the action area support sand, mudflats, and intertidal beaches. There is no clear historical record of the extent of these habitats prior to euro-American settlement. However, the existing shoreline is almost entirely armored and nearly 100 percent of the historic Duwamish Estuary has been filled in due to past historic fill events along the shoreline. It has been confirmed that the upland portion of the PSR site consist of fill that covered a major portion of this type of habitat. Filling, dredging and armoring have diminished the historical extent as well as the function of intertidal habitats around the area. The areas of habitat that remain throughout the PSR-MSU are isolated by development between the habitat patches.

6.6 Estuarine Habitat Quality - Shoreline Modifications

Juvenile salmon are generally found in shallower parts of the estuary preferring gently sloping nearshore areas that provide refuge from large in-water predators. Smaller juveniles are usually found at shallower depths with larger fish gradually migrating to deeper water. For example, chinook smolts 150-250 mm in length have been observed to concentrate at depths of 2-15 feet in deep water (Taylor and Willey 1997). Smaller chum

salmon juveniles (less than 60 mm in length) tend to remain in nearshore, shallow areas while larger juveniles move into deeper water (Roni and Weitkamp 1996; Dames and Moore/Biosonics 1994; Laufle pers. comm.). Juvenile fish prefer low banks and low slope areas because they are usually associated with increased benthic prey abundance (Anchor Environmental/Hart Crowser 1999). There is also some evidence that smaller juvenile fish are reluctant to move into deeper water (Heiser and Finn 1970, Roni and Weitkamp 1996). Bull trout also benefit from nearshore shallow areas because they support many of their prey species. They generally feed in deeper water during the day then move to shallow, gently sloped nearshore areas to feed on fish or epibenthic prey.

Armoring or hardening of the natural shorelines reduces available feeding habitat and increases predation on juvenile salmonids by reducing or eliminating shallow water refugia. Studies in Puget Sound have demonstrated both the individual and cumulative adverse effects on fish migration from shoreline hardening (Macdonald et al 1993). Riprap, bulkheads, and seawalls usually replace or limit the suitable feeding substrates, increase the shoreline slope and reduce the availability of refuge areas, and may also provide habitat for predators. Shoreline hardening also restricts or removes natural riparian and wetland vegetation. Although bull trout often prey on juvenile fish, they also benefit from good quality nearshore habitat specifically because their primary prey sources are juvenile salmonids and epibenthic organisms.

The effects of shoreline structures on migrating juvenile salmon may vary, depending on the design and orientation of shoreline structures, the extent of the alteration of the underwater light fields, and the presence of artificial light (Simenstad et al 1999). Simenstad et al (1999) found literature evidence that juvenile salmon react to shadows and other artifacts in the shoreline environment created by structures. The structures alter the migratory behavior of fish, they reduce prey production and availability, and they may also increase predation.

Field studies provide varying results on the barrier effect of piers. Salo et al (1980) and Bax et al (1980) found that juvenile salmon often migrate around piers. Some studies found that juvenile salmon also swim under piers or congregate next to them (Bax et al 1980). Pentec (1997) observed all of these responses. Goetz (pers. comm.) cautioned that although it is possible that piers may improve bull trout opportunity for predation, they are more likely to benefit from habitat that supports a healthy prey base rather than one that increases the opportunity for predation. The size and species of juvenile salmon reflect their responses to piers, with larger juveniles of all species tending to swim around the end of piers. Different species also tend to respond differently to light or shading conditions created by piers. Weitkamp and Schadt (1981) observed juvenile chinook and chum preferring areas of infiltrating light under piers. In contrast, coho and pink juveniles showed a preference for darker, nearshore areas or showed no preference over light and dark conditions. Laufle (pers. comm.) noted that there is some evidence that salmon are hesitant to swim across abrupt transitions between light and dark.

Although the studies showed different responses, most demonstrated that juvenile fish react to the presence of a pier (except for the smallest piers). This represents at least

some delay on the migration of juvenile salmon. Delayed migration seems to happen when fish are confronted with conflicts regarding their preferences for dark areas, night lighting or turbid zones. The consequences of delayed migration are unknown but are commonly assumed to be detrimental; however, sufficient empirical data do not exist to support or refute this (Simenstad et al 1999).

6.6.1 Existing Conditions - Shoreline Modifications

The shorelines of Elliott Bay and the adjacent shorelines of Puget Sound consist almost entirely of armored (riprap) shorelines. Common shoreline features also include constructed bulkheads and shoreline structures such as piers. Most of the erosion features were constructed to protect the industrial areas of Elliott Bay. In many areas, intertidal shoreline remains in front of the constructed shoreline features, which continue to provide some support function to salmonids. Many of the shoreline areas have also experienced some filling.

6.7 Estuarine Habitat Quality - Current Patterns

EPA assumed that historical or natural current patterns are preferable to any modifications resulting from channel deepening and/or the presence of in-water structures. Best professional judgment was required to differentiate between conditions that contain minor alterations and conditions that are likely to have impacts on biological resources.

6.7.1 Existing Conditions - Current Patterns

PSR-MSU has been dredged in certain areas to facilitate navigation, but dredging has not been extensive and non-existent in recent history. The existing circulation patterns, driven primarily by tidal exchange, are likely very similar to historic patterns.

6.8 Biological Habitat Indicators - Benthic Prey Availability

Epibenthic and benthic invertebrates, including amphipods (Eogammarus and Corophium spp.), harpacticoid copepods, mysids, and cumaceans are important components of the salmonid diet (Healey 1991). Juvenile salmonids typically engage in bottom feeding activities within the littoral zone where shallow water provides some additional protection from predators (between MLLW and MHHW). The condition and availability of benthic and epibenthic organisms within this zone can be used as a measure of level of feeding-function support of juvenile salmonids. Juvenile bull trout and some adults have even greater reliance on benthic feeding. Indicator species or species assemblages that define either good quality or poor quality habitat are difficult to identify because there is

a high degree of naturally occurring variance in benthic species assemblage. However, habitat quality as indicated by the degree of sediment contamination can serve as a surrogate for assessing habitat health as epibenthic and benthic communities generally show a negative response to sediment contamination. Typical responses to contaminant exposure include alterations in species assemblages, reductions in abundance, and lack of recruitment of more sensitive taxa.

6.8.1 Existing Conditions - Benthic Prey Availability

Most of the benthic sampling work done in PSR-MSU is related to observing potential effects of contaminated sediments on benthic infauna. EPA has demonstrated that important prey assemblages exist within PSR-MSU, including species researchers have considered sensitive to pollution. However, sample areas that were associated with known contaminated sediments showed a distinctly different benthic community. The dominant species at the contaminated location are all polychaete worms that are frequently associated with stressed habitats. EPA concluded that the presence of contaminated sediment in unremediated areas adversely affects the species diversity and abundance of benthic organisms and therefore affected the diversity and abundance of the prey resources available to migrating salmonids.

6.9 Biological Habitat Quality - Forage Fish

Forage fish include herring, surf smelt, and sand lance larvae and juveniles are important prey items for larger juvenile salmon. They are also an extremely important prey source for bull trout (Goetz pers. comm.). On average, 35 percent of juvenile salmon diets are comprised of sand lance. This species is particularly important for juvenile chinook, where 60 percent of their diets consist of sand lance (WDFW 1999). Goetz (pers. comm.) also noted that sand lance are a major prey source for bull trout.

Forage fish larvae are ubiquitous in Puget Sound and are a common component of the nearshore plankton. As such, it is difficult to determine the source of this prey item within any given estuary. Very little research has been done to determine if larvae in any given estuary originate in nearby spawning grounds.

6.9.1 Existing Conditions - Forage Fish

Surf smelt and Pacific sand lance spawning occurs on beaches within Puget Sound but not at the PSR-MSU due mainly to the modified shoreline. Spawning habitat was historically more abundant, however, armoring and other shoreline modifications have limited the amount of available spawning areas.

7.0 Analysis of Effects

EPA analyzed the effects of the proposed action by evaluating the individual, cumulative and interrelated and interdependent effects of the separate elements of the action. The separate elements include the following:

- Placement of dredged material (sand) and borrow material (sand and gravel) to form an extension to an existing subtidal area over contaminated marine sediments. **Hereafter, "capping."**
- Remedial activities on the Puget Sound shoreline of the facility. **Hereafter, "Puget Sound shoreline."**
- Dredging of and removal of contaminated sediment. **Hereafter, "dredging"**
- Filling in subtidal habitat. **Here after, "habitat creation"**

EPA determined the effects on chinook salmon and bull trout by predicting changes in indicator function from baseline conditions. EPA analysis of individual effects is discussed in **Section 9** (following).

8.0 Individual Effects

EPA has determined that the effects due to timber pilings removal will be similar to, but much less significant than, the effects due to dredging. Therefore, while the following analyses do not address pilings removal individually, the relatively minimal effects to the water quality habitat, estuarine habitat and biological habitat have been factored into the overall effects determination.

8.1 Water Quality Habitat Indicators

8.1.1 Water Quality - Turbidity

Dredging. Dredging that will occur to remove the contaminated sediment will result in turbidity that is similar to routine navigation dredging of the Duwamish River. EPA will ensure that specifications include standards for turbidity to minimize to the maximum extent practicable re-suspension of *in situ* sediments. Dredging could occur between August 16th and February 15th of any given year.

Capping. Capping will be constructed upon receipt of dredged or upland materials and will continue until project completion**.** Capping can occur between July 16 and February 15 of each year unless modified during consultation with the resources agencies. EPA anticipates that each phase of cap construction (placement of clean sediments) will cause increased turbidity in the immediate area as the sediments disperse through the water column. EPA also expects some re-suspension of bottom sediment as the cap materials come in contact with the bottom.

Pursuant to sediment trap data gathered during the placement of the 1994 cap (Wyckoff site), EPA found no significant amount of contaminated sediments outside of the project area during construction. Most mobilized bottom sediments were entrained

within the capping sediments and re-deposited on the sediment surface where they mixed with clean sediments. The entire capping process eventually contained the contaminated sediments and isolated them from bio-uptake.

The clean cap sediments will be slightly coarser than existing surface substrates with fewer fine-grained particles or organic materials. Any capping material will settle out quickly, with the majority of the material retained in the overall cap footprint. EPA and USACE (1994) evaluated total suspended solids (TSS) during the construction of the 1994 cap in Eagle Harbor and found that conditions returned to background within 30 minutes after a discharge period. They also found that turbidity had an expected increase in the areas of on-going sediment placement and that it was greatest at the bottom of the water column. EPA also found that the increased turbidity was limited in extent to the discharge area. No samples exceeded the requirements of the water quality certification for the 1994 activity. EPA expects the same conditions to occur during the construction of this cap.

EPA will ensure that bid specifications include standards for turbidity to minimize to the maximum extent practicable re-suspension of *in situ* sediments.

Habitat Creation. The area will be backfilled with sediments suitable for forage fish spawning. Any areas that are exposed to tidal influence will be managed using suitable erosion control measures to assure minimal, if any, escapement of sediments into the water during construction. EPA expects some resettlement of substrate materials when the site is fully opened to tidal exchange; however, this effect will be limited in extent and duration.

Puget Sound Shoreline -
EPA will ensure that bid specifications include standards for turbidity that do not exceed State Water Quality Standards for construction.

8.1.1.1 Effects Summary - Turbidity

Short-term Direct Effects. EPA determined that the proposed action would maintain the current water quality function of turbidity in PSR-MSU for the following reasons:

1. Turbidity effects will likely be limited in extent to areas adjacent to the actions. EPA fully expects to be able to meet water quality standards for turbidity and will not exceed the sub-lethal and lethal conditions for salmonids outside of the mixing zone.
2. Turbidity effects will be limited to time periods that do not coincide with peak migration periods of juvenile chinook and use by bull trout.
3. Turbidity will be controlled at the habitat sites to avoid or minimize any discharges to adjacent water bodies.
4. There will be very limited loss of materials during placement of the cap, the engineered embankment, and materials placed on the Puget Sound shoreline because of the use of coarse-grained sediments or rocks with minimal fines.
5. EPA will require careful placement of all materials to minimize re-suspension

of *in situ* sediments.

6. Turbidity will be monitored to assure adherence to State water quality standards.

Short-Term Indirect Effects. Few, if any, juvenile chinook salmon or juvenile and/or adult bull trout are expected to be in the action area during construction activities. Few adult chinook and bull trout are expected in the project area at any time. Short-term and localized increases in turbidity from construction may result in avoidance of the immediate work areas, but are not expected to interfere with salmonid use of the action area.

Long-Term Direct Effects. No long-term direct effects to turbidity are anticipated from any of the construction activities proposed in the action area.

Long-Term Indirect Effects. No long-term indirect effects to turbidity are anticipated from any of the construction activities proposed in the action area.

8.1.2 Water Quality - Dissolved Oxygen

Dredging. Dissolved oxygen will be decreased at the immediate area of the dredging bucket. However, this increase will be under the guidelines for DO and will dissipate rapidly.

Capping. The clean sediments placed for capping are not expected to result in a change in sediment oxygen demand (and resulting DO reduction) during transport through the water column. There may be some re-suspension of anoxic sediments at the sediment surface; however, EPA expects the bottom sediments to be rapidly isolated and entrained in the cap materials. The re-suspension may increase sediment oxygen demand at the sediment surface, but this condition is expected to be extremely temporary in nature and limited in extent.

Habitat Creation. Removing the contaminated sediment or a portion of the sediment and then capping with 5 feet of clean sediment will create new habitat for the benthic community.

Puget Sound Shoreline. EPA expects minor decreases in DO during excavation of contaminated sediments. EPA expects this to be limited to the area of excavation and limited to the time of excavation. EPA also expects same potential impacts to DO as those associated with other capping activities. Impacts would be minor and temporary in nature.

8.1.2.1 Effects Summary - Dissolved Oxygen

Short-Term Direct Effects. EPA determined that the proposed action will maintain the current water quality function of dissolved oxygen in PSR-MSU for the following

reasons:

1. EPA anticipates that any reduction in DO beyond background will be limited in extent and temporary in nature.
2. The placement of sediments and rock (for the engineered embankment) may slightly decrease DO in the immediate placement area because of potential suspension of anoxic bottom sediments. However, EPA expects this change in DO to be limited in extent to the immediate activity area and also limited in duration to the construction period.
3. Construction will adhere to the agreed to in-water work windows that will avoid peak migration and use times for chinook salmon and bull trout.
4. DO will be monitored during construction to assure adherence to State water quality standards.

Short-Term Indirect Effects. Few, if any, juvenile chinook salmon or juvenile and/or adult bull trout are expected to be in the action area during construction activities. Few adult chinook and bull trout are expected in the project area at any time. Short-term and localized increases in dissolved oxygen from construction may result in avoidance of the immediate work areas, but are not expected to interfere with salmonid use of the action area.

Long-Term Direct Effects. No long-term direct effects to dissolved oxygen are anticipated for any of the construction activities proposed in the action area. There may be minor long-term impacts

Long-Term Indirect Effects. No long-term indirect effects to dissolved oxygen are anticipated for any of the construction activities proposed in the action area.

8.1.3 Water Quality - Water Contamination

Dredging. During the pre-design investigation, a dredge elutriate test (DRET) was conducted on a composite sample from RA3. The results of this testing, reported in the pre-design investigation data summary (USEPA 2002a), indicate that chemical concentrations are not expected to exceed either the acute or chronic water quality criteria in WAC 173-201A-040. Thus no further modeling should be required. This chemical concentration will be short lived in the water column and will become non-existent when capped.

Capping. EPA expects some re-suspension of contaminated bottom sediments during cap construction. However, any adverse impacts to water quality via the re-suspension of contaminated sediments will be mostly localized to the cap footprint. Based on the water quality data from the 1994 cap (Wyckoff site), EPA expects little, if any, migration of contaminated sediments away from the cap placement site (EPA and USACE 1994). This is because any resuspended sediment becomes entrained within the clean sediments

and is eventually covered with additional clean sediments. The completed cap surface will consist of clean sediment. The successful placement of the 1994 cap supports EPA's expectations for the activity.

At the completion of Capping Phase, the sediment surface will no longer be contaminated. Placement of the final Capping will result in no releases of contaminants to the water column. EPA expects improvement of water quality conditions after completion of the cap.

Habitat Creation. Only clean materials will be used in the construction of the habitat areas. EPA expects no or very limited contact of any contaminated sediments with the water column during construction. EPA will require best-management practices during construction to minimize any sediment discharges. Habitat creation will result in no releases of contaminants to the water column.

Puget Sound Shoreline. Some contaminated materials may be released if contaminated sediments are excavated from the intertidal shorelines, however no excavation is expected in the intertidal areas. EPA expects this impact to be restricted to the area of excavation and limited in duration.

8.1.3.1 Effects Summary - Water Contamination

Short-Term Direct Effects. EPA determined that the proposed actions will *restore and/or maintain* the current water quality function of water contamination in PSR-MSU for the following reasons:

1. Any oil sheen will be contained and removed with sorbent booms.
2. All materials used for cap placement will be clean and will either replace or isolate contaminated surface sediments providing a clean surface environment.
3. All materials used for the embankment will be clean and placed carefully to minimized re-suspension of contaminated sediments.
4. Construction will adhere to the agreed to in-water work windows that will avoid peak migration and use times for chinook salmon and bull trout.

Short-Term Indirect Effects. No short-term indirect effects are anticipated.

Long-Term Direct Effects. EPA expects that overall water quality will improve as a result of the proposed actions by the isolation of contaminated materials and sediments and the control of upland sources.

Long-Term Indirect Effects. No long-term indirect effects are anticipated.

8.1.4 Water Quality – Sediment

Dredging. The only sediment that will be dredged at the PSR-MSU location will be

contaminated and will be hauled to an upon disposal site. The following will explain how the sediment will be capped.

Capping. All sediments used for capping will be clean and suitable for in-water disposal. With the control of upland source of water and sediment contamination, EPA expects that these sediments will not become re-contaminated after placement or in the foreseeable future. The types of substrates will improve existing habitat conditions by isolating contaminated sediments. Capping will also provide a clean sediment substrate for re-colonization of benthic organisms. The water quality protection methods described in Section 9.1.3 will also protect and/or improve sediment quality.

Habitat Creation. The construction of the intertidal and shallow subtidal habitat will improve overall sediment quality by creating a new, clean intertidal beach environment along the PSR-MSU shoreline.

Puget Sound Shoreline. The remedial activities on the Puget Sound shoreline will result in similar effects as those described for capping.

8.1.4.1 Effects Summary - Sediment Contamination

The purpose of the remedial actions in PSR-MSU is to address unacceptable risks to the environment and public health from the highly contaminated sediments. The proposed action will confine the most highly contaminated sediments through capping . EPA's actions will restore sediment quality to levels at or below the SQSs.

Short-Term Direct Effects. EPA determined that the proposed actions will *restore and/or maintain* the current water quality function of sediment contamination in PSR-MSU for the following reasons:

1. All capping materials will be clean and will isolate contaminated surface sediments providing a clean subsurface environment.
2. EPA will use only clean sediments in the creation and restoration of habitats.
3. Remedial activities on the Puget Sound shoreline will result in a cleaner intertidal environment.
4. EPA will adhere to agreed to construction windows to avoid peak migration and use by chinook salmon and bull trout.
5. Best management practices will prevent recontamination and/or resuspension in other areas.

Short-Term Indirect Effects. No short-term indirect effects are anticipated.

Long-Term Direct Effects. EPA expects that overall sediment quality will improve as a result of the proposed actions by the isolation of contaminated materials and sediments.

Long-Term Indirect Effects. No long-term indirect effects are anticipated

8.2 Estuarine Habitat Quality

8.2.1 Estuarine Habitat Area, Diversity, and Accessibility

Capping. The placement of clean sediments will result in the loss of existing benthic and epibenthic organisms. However, EPA expects that there will be rapid re-colonization of the new clean substrates. Capping will also convert 3 acres of deep subtidal environments to shallow subtidal and intertidal habitats. This, in conjunction with providing a clean substrate, is expected to increase both habitat diversity and productivity. Construction activities may cause avoidance of the adjacent nearshore areas. EPA expects the construction disturbances will be temporary.

Puget Sound Shoreline. Remedial activities on the Puget Sound shoreline would likely result in increased benthic diversity and productivity due to removal of the hot spots of contaminated sediments. Placement of the beach nourishment materials would result in the loss of the current benthic and epibenthic resources. However, these areas would re-colonize rapidly after completion of placement.

Habitat Creation. With the placement of clean sediment in the PSR-MSU the benthic community is expected to rebound rapidly.

Dredging. The dredging will result in the removal of some of the habitat, however, the habitat that will be removed is contaminated and will be capped by clean sediment.

Short-Term Direct Effects. EPA determined that the proposed actions will *maintain and/or restore* the estuarine habitat quality function of habitat diversity, abundance, and accessibility in PSR-MSU for the following reasons:

1. Habitat creation of approximately acres will offset these impacts.
2. Capping will result in the loss of benthic and epibenthic resources. These impacts are expected to be temporary in nature.
3. Capping will increase the intertidal and shallow subtidal area available for juvenile chinook to transit along PSR-MSU shorelines during migration.
4. Capped surfaces will be rapidly re-colonized by prey resources. The clean substrates will also likely support a more diverse and productive benthic and epibenthic community over time.
5. Intertidal habitat will be created in areas where it currently does not exist, thereby increasing habitat area and diversity. It will also increase connectivity with existing habitats, thereby increasing habitat accessibility.
6. Subtidal habitats will be converted to intertidal and shallow subtidal habitat, thereby increasing habitat diversity.
7. Puget Sound remedial activities will result in a temporary decrease, but will likely produce a long-term increase in habitat diversity and productivity.

Short-Term Indirect Effects. Few, if any, juvenile salmonids are expected in the action area during construction activities. Few adult chinook or bull trout are expected in the action area at any time. There will be a short-term loss of benthic and epibenthic communities. However, the areas of lost benthic and epibenthic resources are subtidal

and below the preferred migration depths of juvenile salmonids (below -10 feet MLLW). Other intertidal habitats that provide feeding, resting, and refugia will remain available to both species in the action area. Project construction may result in avoidance of the immediate work areas but are not expected to interfere with any migration activities.

Long-Term Direct Effects. EPA expects that overall habitat quality will improve as a result of the proposed actions. This would be the result of the isolation of contaminated materials and sediments, through the construction of new intertidal beaches, and the conversion of deep subtidal area to shallow subtidal and intertidal areas through capping.

Long-Term Indirect Effects. No long-term indirect effects are anticipated.

8.2.2 Estuarine Habitat Quality – Current Patterns

Capping. Capping may change some of the nearshore wave patterns due to the creation of intertidal beaches along the shoreline (more energy expended on the beach and not deflected back to the harbor). This effect is expected to very localized and will not affect overall current patterns within the bay.

Habitat Creation. Habitat creation is expected to influence the wave pattern by creating more surface area for defusing wave energy instead of deflecting it back to the harbor. This effect is expected to very localized and will not affect overall current patterns within the bay.

Puget Sound Shoreline. Remedial activities on the Puget Sound shoreline will have no effect on current patterns.

Dredging. The actual process of dredging will only impact the current that is directly related to the process. All areas surrounding the dredging process should not be affected or have the current affected.

8.2.2.1 Effects Summary – Current Patterns

EPA determined that the proposed actions will *maintain* the estuarine habitat quality function of current patterns in PSR-MSU for the following reasons:

1. The majority of capping will be subtidal and will not result in any major changes to current patterns within PSR.
2. Habitat creation will increase the available area to defuse wave energy. Overall, it will have minor localized effects on current patterns.

8.2.3 Estuarine Habitat Quality – Shoreline Modifications

Capping. Capping of the subtidal areas will not change the character of the existing

shoreline. However, some capping will create an intertidal beach in an area that is currently subtidal. This will mimic existing shoreline features to the immediate west of the Shoreline. It will also tie into the proposed habitat creation site to the East of the MSU. Both features will provide connection with existing intertidal beaches.

Habitat Creation. Habitat constructed along the shoreline will improve the beach area that consist of failing bulkheads and riprap. This will be replaced by a gently sloped, intertidal beach.

Puget Sound Shoreline. Remedial activities on the Puget Sound shoreline will have no effect on shoreline modification.

Dredging. Dredging should have no effect on the shoreline in this area other than to allow capping to occur and new habitat created.

8.2.3.1 Effects Summary – Shoreline Modifications

EPA determined that the habitat creation activities will *restore and/or maintain* the current estuarine habitat quality function of shorelines in PSR-MSU for the following reasons:

1. The engineered embankment will convert approximately .5 acres of nearshore subtidal area into steep-sloped subtidal and intertidal area.
2. Capping will not result in any additional shoreline structures or increase the area of shoreline armoring. Capping will convert nearshore subtidal habitat into shallow (including intertidal) nearshore habitat.
3. Reconnecting existing intertidal beaches, and will establish a vegetated buffer along the upland margin.

8.3 Biological Habitat Quality

8.3.1 Biological Habitat Quality – Benthic Prey Availability

Capping. Capping will eliminate existing benthic communities by smothering. Most of the benthic organisms are relatively sedentary and have limited ability to burrow through a cap; most are also very small. The capped areas will experience reduced diversity and probably productivity for periods of 2 to 3 years following placement of material as the substrate recolonizes with relatively stable benthic communities. All capping will not occur in one year, therefore, numerous capping events will occur over the lifetime of the project and additional benthic organisms will be smothered. However, recolonization of the new surface will be relatively rapid.

Habitat Creation. The creation of the new beach will increase benthic prey availability (both diversity and production) in PSR-MSU.

Puget Sound Shoreline. Remedial activities on the Puget Sound shoreline would result in a temporary decrease in benthic prey availability, similar to capping. Also similar to capping, EPA expects rapid recolonization of the clean sediment surfaces.

Dredging. Dredging will remove almost all the benthic community that is in the area of the contaminated section to be dredged. However, this areas benthic community is highly contaminated and should be removed from the food chain.

8.3.1.1 Effects Summary – Benthic Prey Availability

EPA determined that the proposed action will *temporarily degrade, but in the long-term, restore* the current estuarine habitat quality function of benthic prey availability in PSR-MSU for the following reasons:

1. Capping will destroy existing benthic communities and reduce overall productivity in PSR-MSU. This condition will last until the completion all capping activities (up to 3 years after completion). However, the cleaner sediments will produce higher benthic diversity and abundance within the foreseeable future.
2. Habitat creation will increase the availability of benthic prey by increasing overall benthic production and diversity in PSR-MSU.
3. Puget Sound shoreline remedial activities are expected to result in minor temporary impacts. Clean-up will likely result in increase benthic prey diversity and productivity.

8.3.2 Biological Habitat Quality – Forage Fish Community

Capping Effects. Adult and juvenile forage fish will likely avoid the activity area and some eggs and larvae will likely be entrained during capping. There will be no capping in known or potential spawning beaches. Capping will provide additional (potential) area for forage fish spawning (see discussion under Habitat Creation below).

Habitat Creation. Existing beach elevations adjacent to the area indicate that this is not a likely spawning area. However, known surf smelt spawning beaches are near the mitigation area (to the west in West Seattle). Construction generated sediments may affect the substrate of the adjacent beaches. Careful control of construction sediments will avoid or minimize this potential impact. Adult forage fish will likely avoid the area during construction but will likely return upon project completion.

The purpose of the mitigation area is to create habitat that is suitable for forage fish spawning. While this will not guarantee use by spawners, it will not degrade the use and functions of existing habitats. It may even provide additional spawning areas.

Puget Sound Shoreline.

Adult and juvenile forage fish are expected to avoid the areas of active construction, so that they will be unavailable as prey resources in the activity area. These actions are likely to be very restricted to the activity areas. No known spawning habitat (beaches, aquatic vegetation, etc.) will be impacted by construction and EPA will be consulting closely with WDFW.

Dredging. Dredging may interfere with forage fish as they contact the sediment plume that could result from the dredging operation. This impact will be site specific and should not have a major or long term impact on forage fish.

8.3.2.1 Effects Summary – Forage Fish

EPA determined that the proposed project will *maintain* the current estuarine habitat quality function of forage fish community in PSR-MSU for the following reasons:

1. Adult forage fish can avoid the area during construction.
2. There will be no construction or capping in known forage fish spawning areas.
3. Capping will not occur during the agreed to fish windows to avoid peak migration and use by juvenile chinook and bull trout. The limited availability of forage fish as a prey resource in the action area will not be critical to the support of migrating juveniles or bull trout.
4. The created habitat is intended to increase the area of potential spawning habitat within PSR-MSU.

Table 9.3 Summary of Effects

INDICATOR	FEATURE	EFFECTS			
		Restore	Maintain	Degrade	
				Short-term	Long-term
Turbidity	*Capping*		X		
	Habitat Creation		X		
	Dredging			X	
Dissolved Oxygen	*Puget Sound Shoreline*		X		
	Capping		X		
	Habitat Creation		X		
	Dredging			X	
Water Quality	*Puget Sound Shoreline*		X		
	Capping	X			
	Habitat Creation		X		
	Dredging			x	
Sediment Quality	*Puget Sound Shoreline*	X			
	Capping	X			
	Habitat Creation	X			
	Dredging			X	
	Puget Sound Shoreline	X			

		Restore	Maintain	Degrade	
				Short-Term	Long-Term
Estuarine Habitat Area, Diversity, Accessibility	*Capping*		X	X	
	Habitat Creation	X			
	Dredging			X	
Current Patterns	*Puget Sound Shoreline*		X		
	Capping		X		
	Habitat Creation		X		

	Dredging			X	
Shoreline Modification	*Puget Sound Shoreline*		X		
	Capping		X		
	Habitat Creation	X			
	Dredging		X		
Benthic Prey Availability	*Puget Sound Shoreline*		X		
	Capping	*Long Term* X		X	
	Habitat Creation	X			
	Dredging			X	
Forage Fish Community	*Puget Sound Shoreline*	*Long Term* X			
	Capping		X		
	Habitat Creation	X			
	Dredging			X	
	Puget Sound Shoreline		X		

9.0 Beneficial Effects

EPA, through its responsibilities under CERCLA/SARA, has concluded that sediments in PSR-MSU are contaminated with a high number of hazardous substances at concentrations greatly exceeding those found in Puget Sound reference areas. EPA also concluded that if the remedial activities specified in the ROD are not undertaken, the actual or threatened releases of hazardous substances may present an imminent and substantial endangerment to human health and the environment. As such, EPA is required to pursue actions that will control the release of hazardous substances.

EPA expects significant beneficial effects as a result of this action. Specifically, EPA's action will reduce sediment contamination to levels that are protective of human health and the environment. EPA expects to significantly reduce the exposure of fish and wildlife to hazardous materials, to increase the area of beneficial habitat, and to increase benthic diversity and productivity by providing cleaner substrates. This action also will assist in the improvement of sediment and water quality throughout PSR-MSU by removing and/or isolating contaminated materials.

9.1 Interrelated and Interdependent Effects

Interdependent actions are those which have no independent utility apart from the action being considered. Interrelated actions are activities that are part of the larger action and depend on the larger action for their justification. No interrelated and interdependent effects are associated with this action.

9.2 Cumulative Effects

Cumulative effects are defined in 50 CFR part 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." The proposed action under consideration encompasses a portion of Elliott Bay. This area is currently an ecosystem altered by previous dredging, filling, sewage and industrial discharges, and other anthropogenic activities over the past 100 years. Future federal actions including additional activities permitted under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act will be reviewed under separate Section 7 consultation processes and are not considered cumulative effects.

9.3 Conclusion

The proposed action is in an area that has degraded baseline conditions such as limited habitat for feeding and refuge and contaminated sediments. The proposed action will reduce sediment contamination thereby resulting in greatly improved environmental conditions over time. In addition, mitigation activities to create intertidal and shallow subtidal habitat will offset habitat loss due to project construction.

10.0 EFFECTS DETERMINATION

10.1 Chinook Salmon

Permanent cleanup and/or confinement of contaminated sediments are the primary purposes of this remedial action. Thus, in the long-term, the remedial action will address unacceptable risks to the environment and public health, and reduce the levels of contamination in sediments. The project's long-term effects will help improve and restore salmon habitat in PSR-MSU.

EPA acknowledges, however, that there may be some short-term adverse impacts to chinook due to construction activities. Of the nine habitat indicators, two were found to have short-term effects to estuarine habitat area, diversity, accessibility and benthic resources due to placement of the cap. All other indicators would be maintained or

restored by the project.

Construction will result in temporary degradation of the water quality indicators. However, these effects would be limited to the immediate construction site and would not have an overall adverse effect on the action area. Conservation measures, including avoidance of the juvenile salmon migration period, would prevent adverse short-term effects to salmon during construction.

To address habitat concerns, EPA will construct intertidal and shallow subtidal habitat for chinook salmon and design Capping to create an intertidal beach. In addition to the intertidal beach, EPA will implement other conservation measures to minimize potential short-term effects (see Section 12). These conservation measures will adequately address potential effects to chinook and short-term effects due to construction activities. EPA had determination that the proposed action **may affect, but is not likely to adversely affect, chinook salmon.**

10.2 Bull Trout

Bull trout have not been previously found in PSR-MSU due to the distance of this water body from the major river systems known to support bull trout (Puyallup and Skagit Rivers). However, individuals have been caught on the western side of Puget Sound, so their use of any available habitat must be assumed. Bull trout are opportunistic apex predators that likely follow juvenile salmonid and also likely use the same habitats for additional feeding and refugia. As such, EPA determined that the proposed action **may affect, but is not likely to adversely affect, bull trout** for the same reasons identified for chinook salmon.

11.0 Critical Habitat

"Critical habitat" for listed species is considered to consist of areas where the physical and/or biological features are essential to the conservation of the species. Estuarine habitats, like those within PSR-MSU, provide critical feeding, resting, and refugia functions important to both species.

The critical habitat that may be adversely impacted by this project consists of the following:

1. Short-term impacts due to the cap construction and the construction of the engineered embankment for the cap (riprap).

The critical habitat that would be beneficially affected by this project consists of the following:

1. Creation of approximately 0.64 acres of intertidal and shallow subtidal

habitats
2. Conversion of approximately 1.29 acres of subtidal habitats to intertidal and shallow subtidal habitat.

12.0 Conservation Measures

The following conservation measures are actions that EPA will take to reduce or eliminate the adverse impacts to chinook salmon and bull trout associated with the proposed action in the action area. EPA has determined that the adverse impacts have been sufficiently mitigated.

12.1 Avoidance/Minimization of Short-Term Effects

1. EPA will adhere to all agreed timing restrictions that are protective of migratory periods for juvenile salmonids and potential use periods for bull trout.
2. EPA has selected a placement method for cap construction that will minimize short-term impacts to water quality (including water contamination).
3. Water quality monitoring would be conducted to aid in ensuring that applicable standards are not exceeded outside specified dilution zones (by the EPA's 401 compliance determination).
4. EPA will require that all prudent and necessary steps be taken to assure that no petroleum products, chemicals, or other toxic materials will enter the water from the construction equipment (BMP).
5. A boom will be placed around the dredge during this operation to ensure capture of material.

12.3 Additional Measures

The habitat creation actions are designed to support forage fish habitat that also provides critical habitat for juvenile chinook and bull trout (as well as other estuarine species). In addition, Capping will be specifically designed to provide shallow subtidal and intertidal habitat. This includes creation of intertidal and subtidal habitat, restoration of connectivity to existing estuarine habitats, and increased diversity of habitats in PSR-MSU. These measures are intended to offset the degradation of estuarine area, diversity, and accessibility and benthic prey availability that would result from project implementation.

Specific critical habitat support elements include:

1. Creation of approximately 0.64 acres of intertidal beach;
2. Conversion of approximately 1.29 acres of subtidal to shallow subtidal and intertidal habitat;
3. In areas where riprap is used for slope stability, fishmix will be placed over the riprap at elevations above –10 feet MLLW to enhance habitat value;
4. Placement of the cap material will result in a net increase of 1.29 acres of littoral habitat by conversion of an equivalent area of sublittoral habitat.

13.0 Effects of Actions on other listed Species

13.1 Bald Eagle (*Haliaeetus leucocephalus*)

Nesting and wintering populations in almost all recovery areas in Washington, including the West Cascade Mountains recovery zone, have reached levels that will allow de-listing. However, habitat loss, degradation, and major disturbance factors continue to be serious problems that must be guarded against to assure population gains are not diminished.

The bald eagle is found along the shores of saltwater and freshwater lakes and rivers. In Washington, breeding territories are located in predominantly coniferous, uneven-aged stands with old-growth components. Territory size and configuration are influenced by a variety of habitat characteristics, including availability and location of perch trees for foraging, quality of foraging habitat and distance of nests from waters supporting adequate food supplies. Habitat models for nesting bald eagles in Maine show that the eagles select areas with (1) suitable forest structure, (2) low human disturbance, and (3) highly diverse or accessible prey (Steenof 1978).

Bald eagles typically build nests in mature old-growth trees, which are generally used in successive years. In Washington, courtship and nest-building activities generally begin in January and February. Egg laying begins in March or early April, with eaglets hatching in mid-April or early May. Eaglets usually fledge in mid-July and often remain in the vicinity of the nest for another month (Steenof 1978).

Bald Eagles are adaptable, feeding on whatever is most expedient. Eagles often depend on dead or weakened prey, and their diet may vary locally and seasonally. Various carrion, including spawned salmon taken from gravel bars along wide, braided river stretches, serve as important food items during fall and winter. Waterfowl often are taken as well. Anadromous and warm-water fishes, small mammals, carrion, and seabirds are consumed during the breeding season (Steenof 1978).

13.1.1 Occurrence in the Project Area

Bald eagles are year-round residents in the vicinity of PSR-MSU. The nearest reported nest is on the northern shore of the harbor near Wing Point. The most likely

food resource items in the area are gulls, waterfowl, and fish.

13.1.2 Analysis of Effects

Effects of the proposed action to bald eagles include disturbance from construction and increased turbidity around the project site that may inhibit foraging and reduced food availability. Noise (running heavy equipment) and activities from construction will likely cause prey fish to avoid the immediate area of occurrence. EPA expects the eagles will avoid the immediate area and forage elsewhere. The proposed project represents a small portion of the normal foraging habitat for eagles in the areas, so no significant effects on foraging or prey availability is expected.

Any interference with eagle activity will end when construction is completed. Eagle prey availability should not be substantially affected while the benthic community is re-established in the capped areas. The effects are expected to be localized and temporary. In addition, local bald eagle populations are likely acclimated to vessel traffic, as this is a heavily utilized area (e.g., boat and barge traffic). Long-term degradation of eagle habitat is not expected. Survival and reproductive success of eagles will be unaffected. Containment of contaminated sediments may also limit the extent of possible exposure to hazardous substances.

13.1.3 Cumulative, Interrelated or Interdependent Effects

There will be no significant cumulative, interrelated or interdependent effects on this species from the proposed project in conjunction with other projects or actions.

13.1.4 Conservation Methods

Conservation methods listed in Section 12 will also serve to minimize potential effects on bald eagles. No additional conservation measures are warranted.

13.1.5 Effect Determination

The proposed action will not result in any long-term degradation of habitat or other adverse effects on bald eagles. Short-term effects such as noise disturbance and reduced prey availability will not occur or will be very small in magnitude. The survival or reproductive success of eagles in the project vicinity will not be affected. Therefore, the proposed action **may affect, but is not likely to adversely affect, the bald eagle.**

13.2 Stellar Sea Lion (*Eumetopias jubatus*)

The Stellar sea lion is the largest member of the family Ottariidae. The population is estimated at just under 200,000, with the majority occurring in Alaska. The range of the Stellar sea lion extends around the North Pacific Ocean rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and Bering Sea, along Alaska's southern coast, and south to California (Kenyon and Rice 1961; Loughlin et al 1984). In Puget Sound, Stellar sea lions are rarely found south of Admiralty Inlet,

which is well north of the study area (Yates 1988).
The breeding range of Stellar sea lions extends from southern California to the Bering Sea (Osborne 1988). Though geographically widespread, most breeding takes place in Alaska (Everitt et al 1979). Breeding colonies consisting of small numbers of sea lions are found on the outer coasts of Oregon and British Columbia. There are currently no breeding colonies in Washington State (NMFS 1992; Everitt et al 1979), and no haul-out areas are located in central or south Puget Sound.

Stellar sea lion habitat includes both marine and terrestrial areas that are used for a variety of purposes. Terrestrial areas (e.g., beaches) are used as rookeries for pupping and breeding. Rookeries usually occur on beaches with substrates that include sand, gravel, cobble, boulder, and bedrock (NMFS 1992). Haul-out areas are used other than during the breeding and pupping season. Sites used as rookeries may be used as haul-out areas during other times of the year. When Stellar sea lions are not using rookery or haul-out areas, they occur in nearshore waters and out over the continental shelf. Some individuals may enter rivers in pursuit of prey (Jameson and Kenyon 1977).

Stellar sea lions are opportunistic feeders and consume a variety of fishes such as Pacific hake, cod, halibut, rockfish, skates, flatfish, and rockfish and invertebrates such as squid and octopus. Demersal and off-bottom schooling fishes predominate (Jones 1981). Stellar sea lions along the coasts of Oregon and California have eaten rockfish, hake, flatfish, cusk eel, squid, and octopus (Fiscus and Baines 1966; Jones 1981; Treacy 1985); rockfish and hake are considered to be consistently important prey items (NMFS 1992). Feeding on lamprey in estuaries and river mouths has also been documented at sites in Oregon and California (Jones 1981, Treacy 1985). Spalding (1964) and Otesiuk et al (1990) have documented Stellar sea lions feeding on salmon, but they are not considered to be a major prey item (Osborne 1988).

Responses to various types of human-induced disturbances have not been specifically studied. Close approach by humans, boats, or aircraft will cause hauled-out sea lions to go into the water. Disturbances that cause stampedes on rookeries may cause trampling and abandonment of pups. Areas subjected to repeated disturbance may be permanently abandoned (Kenyon 1961), and/or the repeated disturbance may negatively affect the condition or survival of pups through interruption of normal nursing cycles. Low levels of occasional disturbance may have little long-term effect (NMFS 1992).

13.2.1 Occurrence in the Project Area

There are no Stellar sea lion rookeries in the State of Washington, although Stellar sea lions are occasionally found in Washington State waters. They move into Puget Sound in the fall and forage throughout the inland waters. Their favorite haul-out areas are in northern Puget Sound at Race Rocks, Sombrio Point, and Sucia Island, but are rare south of Admiralty Inlet (Yates 1988). Jagged Island and Split Rock are used as summer haul-outs, and Umatilla reef is used in the winter. Additional haul-out sites include Willoughby Rocks on the south Washington coast and at Carroll Island, Cape Alava, and Tatoosh Island on the north Washington coast. In 1992 and 1993, nursing pups were

observed at Carroll Island and Cape Alava. These pups may have been born in Washington or may have migrated with their mothers from rookeries in British Columbia or Oregon (NFMS 1992). There are no data available to evaluate trend numbers in Washington State waters (NFMS 1992).

13.2.2 Analysis of Effects

Effects on Stellar sea lions that may occur in PSR-MSU will result primarily from turbidity caused by construction activities, disturbance from operation of equipment, and effects on food resources such as fish. The effects of turbidity and construction activities will be localized and temporary. Because they are highly mobile, sea lions will likely avoid the area during construction. This will have no effect on foraging and other behavior because the avoided areas do not contain normal foraging, resting, or transit habitat for this species. No degradation of Stellar sea lion habitat will occur as a result of this project.

13.2.3 Cumulative, Interrelated, and Interdependent Effects

For the reasons described in Section 12, there will be no significant cumulative, interrelated or interdependent effects on this species from the proposed project in conjunction with other projects or actions.

13.2.4 Conservation Measures

Temporary effects on water quality will be minimized by adherence to measures outlined in Section 12. No additional conservation measures are warranted.

13.2.5 Effect Determination

Stellar sea lions are not expected to be present in the project area. Any Stellar sea lions that might be present will experience only localized and temporary effects from the action. Because Stellar sea lions are highly mobile, they are expected to readily avoid the project area. Therefore, the proposed action will have **no effect** on the stellar sea lion.

13.3 Humpback Whale (*Megaptera novaeangliae*)

Humpback whales are endemic to the North Pacific. Humpback whales inhabit coastal waters and are typically found within about 50 nautical miles from shore (Evans 1987; Calambokidis and Steiger 1995). The coastal waters that attract the whales represent areas of high productivity in plankton and forage fish that are important food sources for these animals (Evans 1987). They are dependent on these abundant food resources because of their size and metabolic needs for reproduction, nursing, and sustenance during times of the year when food resources are less abundant (i.e., wintering grounds) (Evans 1987).

Three groups have been identified based on summer and winter range distributions (Calambokidis et al 1997b). The population was reduced to about 13 percent of the carrying capacity by commercial whaling (Braham 1991) and is now estimated to number between 6,000 and 8,000 animals (Calambokidis et al 1997b). The three population groups spend the summer off the Aleutian Islands to Southeast Alaska, the Washington/British Columbia coast, and California. The Alaska group migrates to winter grounds in Hawaii. The group off the Washington/British Columbia coast splits between three wintering areas in Hawaii, Mexico, and Japan. The California group migrates primarily to wintering grounds off Mexico to Costa Rica (Calambokidis et al 1997b, 1998a). The greatest numbers of animals winter off Hawaii (about 4,000 to 5,000), with Mexico second (1,600 to 4,200) and Japan representing the smallest wintering group (about 400). The summer grounds are used for feeding; the wintering grounds are used for breeding and calving (Evans 1987).

Humpback whales use coastal habitats because of their productivity. They would not be expected to be routinely present in Puget Sound because of the lack of appropriate habitat and food availability for these large mammals. This expectation is based on limited data, because most studies of these animals are focused on the areas the whales frequent not areas where they are rarely if ever seen. The Cascadia Research Institute conducts studies on marine mammals in Puget Sound and throughout the North Pacific Ocean. They reported that one of two humpback whales seen in central and southern Puget Sound in 1988 was sighted near the southwest corner of Commencement Bay off the mouth of the Thea Foss Waterway (Calambokidis and Steiger 1995). They have reported no humpback whales as incidental sightings in Puget Sound during recent marine mammal surveys (Calambokidis et al 1994 and 1997a; Calambokidis and Quan 1997; Calambokidis 1996). A humpback was seen in the Strait of Juan de Fuca in June of 1999 (Cascadia Research Institute pers. comm.).

Responses to various types of human-induced disturbances have not been specifically studied. Close and fast approaches by boats or aircraft may cause humpback whales to disperse or interrupt feeding, migration patterns, or nursing activities. Little is known about what effects, if any, activities associated with coastal development might have on humpback whales. Certain manmade sounds cause migrating whales to deviate from their course (Tyack et al 1983). Daily dredging and vessel traffic in a calving lagoon caused gray whales to abandon the area for 6 years (Rice et al 1984). Feeding or breeding areas subjected to repeated disturbance could potentially be abandoned, and/or repeated disturbance could negatively affect the condition or survival of calves through interruption of nursing cycles.

Abundance estimates from a recent major collaboration between researchers in the North Pacific Basin indicate that 6,000 to 8,000 humpback whales inhabit this area. These animals distribute themselves along the Pacific Coast of North America during the summer for feeding (Calambokidis et al 1997b). Calambokidis et al (1998b) characterize the population as showing a higher proportion of calves in recent years that is “closer to that expected of a healthy increasing population.” Comparisons of current abundance estimates with the end of commercial whaling in the 1960s indicate a growing

population. The current stock status appears to be one of a healthy, increasing population.

13.3.1 Occurrence in the Project Area

Sightings of humpback whales are uncommon along the coast of Washington, although the National Marine Mammal Laboratory (NMML) has documented humpbacks in Washington State waters in every month except February, March, and April. Humpbacks probably use Washington waters as a migration corridor. The Washington Coast had historically higher populations than exist today. Extensive whaling around the turn of the century severely depleted the populations. Humpbacks were landed in the 1900s in the Bay City (WA) whaling station from April to October. The most whales were taken between June and August.

Humpback whales have been intermittently sighted in Puget Sound. Sightings occurred off of Seattle in May 1996 and September 1978. In June and July of 1988, two individuals were observed near Tacoma and Olympia (Parametrix 1991). Humpbacks observed in Puget Sound do not remain for long periods and are considered stragglers.

13.3.2 Analysis of Effects

Effects of the proposed action on humpback whales occurring in the vicinity of PSR-MSU would result primarily from turbidity caused by construction, disturbance from the operation of equipment, and effects on food resources. The effects of turbidity and disturbance by construction will be localized and temporary. Because they are high mobile, humpbacks would likely avoid the immediate site during construction. This should have minimal, if any, effect on foraging and other behavior because the action area would be a very small part of the normal foraging, resting, or migration habitat for humpback whales. No long-term degradation of habitat for humpback whales will occur as a result of the proposed action.

13.3.3 Cumulative, Interrelated, and Interdependent Effects

For reasons described in Section 13.3.2, there will be no significant cumulative, interrelated or interdependent effects on humpback whales from the proposed project in conjunction with other projects or actions.

13.3.4 Conservation Measures

No conservation measures are warranted.

13.3.5 Effect Determination

The proposed action will have **no effect** on the humpback whale.

13.4 Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback turtle is the largest living turtle; the average adult has a curved carapace length of 155 cm and weighs from 200 to 700 kg (NMFS 1999b). It is a highly pelagic species, generally approaching shores only during the reproductive season. Small groups of individuals have been reported moving together in coastal waters, although these have been centered on concentrations of jellyfish, on which they feed. Leatherbacks seldom form large aggregations.

The leatherback turtle is well adapted to temperate climates because of its ability to thermoregulate; thus it is one of the most widely distributed of all turtles. Their breeding grounds are located in the tropical and subtropical latitudes, although they are regularly seen in more temperate areas (Poland 1996). The Eastern Pacific Ocean has the highest number of nesting sites, particularly on the western coast of Mexico (Poland 1996). There are no known nesting areas on central Pacific islands, but nesting has been recorded on South Pacific islands. The nesting period for the eastern Pacific turtle is from October to March (Poland 1996). Leatherback turtles nest only on high-energy, steep-shelving beaches immediately adjacent to deep water and where there are no fringing reefs. Nests are sited on or just above the high water mark.

Very little is known about the life history of the leatherback turtle from emergence to reaching sexual maturity. The leatherback turtle feeds mainly on pelagic invertebrates, such as jellyfish and tunicates, crustaceans, and juvenile fish. Marine plants are often ingested accidentally. The feeding behavior of juveniles is unknown, but it is thought that they are pelagic and follow warm currents and eddies offshore in search of food (Poland 1996).
Nesting populations of leatherback turtles are especially difficult to discern because the females frequently change beaches. However, current estimates are that 20,000 to 30,000 female leatherbacks exist worldwide (NMFS 1999b).

Populations have declined in Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua, New Guinea. Leatherbacks are seriously declining at all major nesting beaches throughout the Pacific. Nesting along the Pacific coast of Mexico declined at an average rate of 22 percent over the last 12 years, and the Malaysian population represents 1 percent of the levels recorded in the 1950s. The collapse of nesting populations was precipitated by a tremendous over-harvest of eggs, direct harvest of adults, and incidental mortality from fishing (NMFS 1999b).

Leatherback turtles do not nest frequently enough in the United States to assess an accurate trend. The recovery plan for the turtles concluded that the nesting trends in the United States appear stable, but the population faces significant threats from incidental take in commercial fisheries and marine pollution (NMFS 1999b).

13.4.1 Occurrence in the Project Area

Leatherback sea turtles are occasionally sighted in British Columbia and Alaska

as far west as the Aleutian Islands. They have also been documented off Washington and Oregon; there have been 9 leatherback stranding or sightings between 1981 and 1991. Only three sightings occurred in Washington inland waters during this time. These occurred in the Strait of Juan de Fuca and the Strait of George (NFMS 1992). They may occasionally enter Puget Sound, but there are no reported sightings.

13.4.2 Analysis of Effects

Effects of the proposed action on leatherback sea turtles that may occur in the project area will result primarily from turbidity, disturbance from operation of equipment, and effects on food resources. The effects of turbidity and disturbance by the construction operations will be localized and temporary. Because they are highly mobile, turtles would likely avoid the immediate site during construction. This would have a minor effect on foraging, resting, or migration habitat for these species. There will be no significant reduction in short-term food availability for these species due to temporary avoidance of the immediate sites. No long-term degradation of habitat for leatherback sea turtles will occur as a result of this project.
Since leatherback sea turtles are not expected to occur in Elliott Bay and no designated critical habitat occurs in the project area, no adverse effects are expected.

13.4.3 Cumulative, Interrelated, and Interdependent Effects

For reasons described in Section 13.4.2, there will be no significant cumulative, interrelated, or interdependent effects on this species from the proposed action in conjunction with other projects or actions.

13.4.4 Conservation Measures

No conservation measures are warranted.

13.4.5 Effects Determination

The proposed action will have **no effect** on the leatherback sea turtle.

13.5 Marbled Murrelet (*Brachyramphus marmoratus*)

Marbled murrelets are small seabirds of the family Alcidae, which includes puffins, murres, and auklets. They are about 10 inches long and occur along the north Pacific coast from the Aleutian Islands and southern Alaska south to Central California. Murrelets feed on fish and invertebrates usually within two miles of shore. They nest in stands of mature and old growth forest. Nesting trees in Washington State have been found as far as 30 miles from the ocean. The marbled murrelet typically forages for prey during the day and visits its nest site in the canopy of old-growth forests at dawn or dusk.

The U.S. Fish and Wildlife Service listed the marbled murrelet in 1992 under the

Endangered Species Act as a federally threatened species in California, Oregon, and Washington. Marbled murrelet critical habitat includes include 11 units in Washington State, including 1.2 million acres of Federal land, 421,500 acres of State forest land and 2,500 acres of private land.

13.5.1 Occurrence in the Project Area

The occurrence of marbled murrelets in PSR-MSU is rare and nesting sites have not been seen in the vicinity. They are not expected to nest in the vicinity due to the lack of old growth forests. The nearest critical habitat is on the Olympic Peninsula approximately 20 miles to the west. Marbled murrelets may forage within PSR-MSU, but they have rarely been seen around Elliott Bay.

13.5.2 Analysis of Effects

Effects of the proposed action to marbled murrelets include construction activity and increased turbidity around the project site that may inhibit foraging and reduced food availability. Noise and activities from construction will likely cause prey fish to avoid the immediate area of occurrence. EPA expects the murrelets will avoid the immediate area and forage elsewhere. The proposed project represents a small portion of the normal foraging habitat for marbled murrelets in the areas, so no significant effects on foraging or prey availability is expected.

Any interference with murrelet activity will end when construction is completed. The effects are expected to be localized and temporary. Long-term degradation of habitat is not expected. Survival and reproductive success of marbled murrelet will be unaffected. Containment of contaminated sediments may also limit the extent of possible exposure to hazardous substances.

13.5.3 Cumulative, Interrelated or Interdependent Effects

There will be no significant cumulative, interrelated or interdependent effects on this species from the proposed project in conjunction with other projects or actions.

13.5.4 Conservation Methods

Conservation methods listed in Section 12 will also serve to minimize potential effects on murrelets. No additional conservation measures are warranted.

13.5.5 Effect Determination

The proposed action will not result in any long-term degradation of habitat or other adverse effects on marbled murrelets. Short-term effects such as noise disturbance and reduced prey availability will not occur or will be very small in magnitude. The survival or reproductive success of marbled murrelet in the project vicinity will not be

affected. Therefore, the proposed action will have **no effect** on the marbled murrelet**.**

13.6 Effect Summary - Additional Listed Species

The proposed action is not likely to adversely affect bald eagle. No critical habitat for the species will be affected. Conservation measures proposed for bull trout and chinook salmon will also benefit these species. The proposed action will most likely result in beneficial effects to both species because of clean up and containment of contaminated sediments and the creation of intertidal habitat.

The proposed action will have **no effect** on humpback whale, marbled murrelet, Stellar sea lion, and leatherback turtle.

14.0 Future Coordination

This BA is in a final stage and is based on a 90% design of the proposed project. The purpose of the final BA is to allow resource agencies an opportunity to review and comment on the understood conditions at the 90% design stage. Continuous coordination will occur during the life of the project; however EPA would like to have a more intensive coordination with the resource agencies until the 90% design and final BA can be completed.

15.0 Essential Fish Habitat

Public Law 104-267, the Sustainable Fisheries Act of 1996, amended the Magnuson-Stevens Act, which regulates fishing in US waters, to establish new requirements for "Essential Fish Habitat" (EFH) descriptions in federal Fishery Management Plans (FMPs) and to require federal agencies to consult with the National Marine Fisheries Service (NMFS) on activities that would adversely effect EFH (PSMFC 2000). The Pacific States Fishery Management Council amended the Pacific Groundfish Fishery Management Plan and the Coastal Pelagic Species Management Plan (1998a, 1998b) to designate waters and substrate necessary for spawning, breeding, feeding, and growth of commercially important fish species.

The marine extent of groundfish and coastal pelagic EFH includes those waters from the nearshore and tidal submerged environments within Washington, Oregon, and California state territorial waters out to the exclusive economic zone (370.4 km) offshore between the Canadian border to the north and the Mexican border to the south.

There are seven composite EFH's: estuarine, rocky shelf, non-rocky shelf, canyon, continental shelf/basin, neritic and oceanic habitats.

The primary effects of dredging and capping on benthic organisms include removal or disturbance of habitat, smothering of organisms at the capping site, and turbidity that may interfere with feeding and respiration of benthic invertebrates. Dredging will temporarily reduce the populations of the benthic community and prey species at the project site. Although research indicates the loss of a potential food source could result in a loss of salmonid and/or groundfish presence, there were no studies accomplished to support this theory. Since new communities will eventually be established in the dredging and capping area, no long-term loss of biological productivity is expected. Benthic and epibenthic prey species will be temporarily displaced, but are expected to recover shortly (within one year) after dredging activities are completed. However, these species tend to recolonize quickly once the disturbance ends. Given the history of the sediment load within this estuary, rapid re-colonization, and adherence to fish windows (February 15-July 15), the determination on the benthic community is likely to adversely affect EFH for salmonids, groundfish and other finfish.

- Disposal operations and material effects would be in conformance with approved disposal site management standards.
- Dredging would be carried out in compliance with permits issued by the responsible regulatory agencies. These permits may include additional conditions to protect water quality. Contaminated dredge material will be removed to an upland disposal site.

- Capping material will be used to enhance benthic and epibenthic habitat within the project area.

The Corp believes the above mentioned guide lines will offset any potential impacts to EFH.

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