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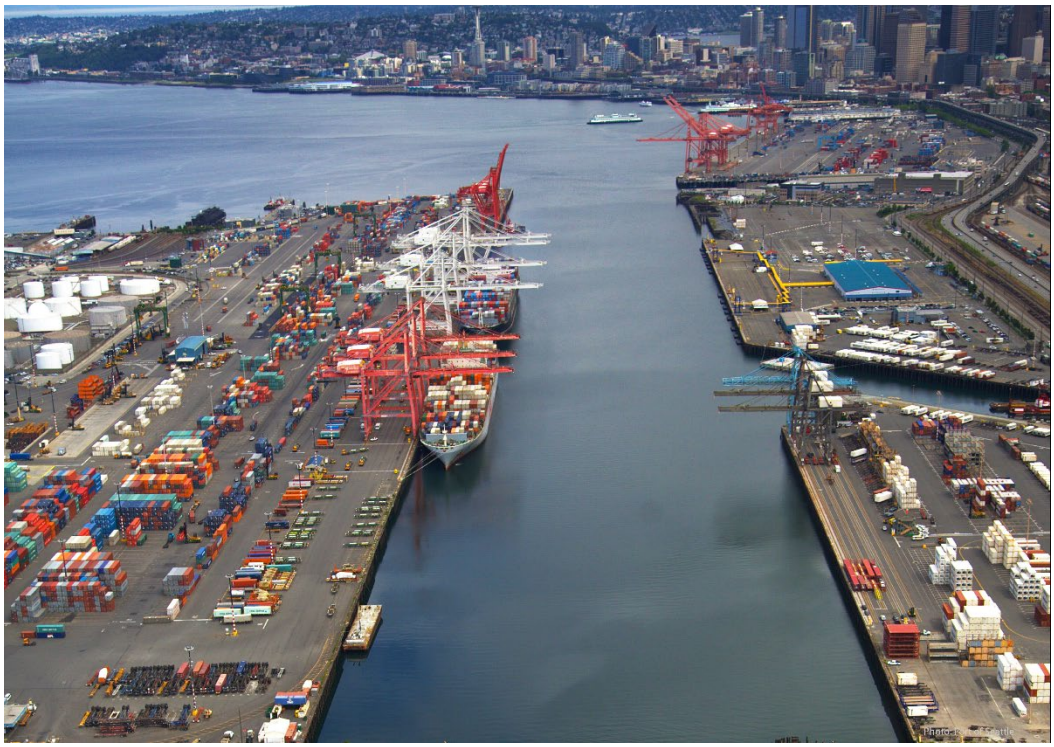
East Waterway Operable Unit Harbor Island Superfund Site



Eleven Principles Information Package Contaminated Sediment Technical Advisory Group

United States Environmental Protection Agency Region 10

February 2018

Eleven Principles Consideration Memorandum
East Waterway Operable Unit, Harbor Island Superfund Site, Seattle, Washington

INTRODUCTION

This Consideration Memorandum for the East Waterway Operable Unit (OU), of the Harbor Island Superfund site (East Waterway) was prepared to highlight the proposed remedial elements and related issues for review by the Contaminated Sediment Technical Advisory Group (CSTAG) and National Remedy Review Board (NRRB). U.S. Environmental Protection Agency (EPA) Region 10 is initiating this consultation as part of the planning process for a Superfund remedial action at the East Waterway, to be further detailed in the upcoming Proposed Plan.

Topics presented in this Consideration Memorandum address the 11 risk management principles outlined in EPA's February 12, 2002, Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-08 *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites.* The information presented in this Consideration Memorandum follows Region 10's review of the draft Feasibility Study (FS). Additional information can be found in the East Waterway OU NRRB Site Information Package posted on the NRRB SharePoint site.

The East Waterway (EW) is an OU of the Harbor Island Superfund site located in Seattle, Washington and is immediately downstream of the Lower Duwamish Waterway (LDW) Superfund site. The East Waterway is a 1.5-milelong, 157-acre maintained waterway in one of Seattle's primary industrial and commercial areas (Exhibits 1 and 2). The EW was created during the construction of Harbor Island in the early 1900s to serve developing industries and commerce in Seattle. Historical activities on the waterway have included marine terminals, shipyards, bulk fuel terminals, recycling and scrap metal yards, cement manufacturing, log handing, small boat marinas, boat manufacturing and repair, as well as many other activities. Today, the East Waterway is an active industrial waterway used primarily for container loading and transport. Land use, zoning, and land ownership along the waterway have been consistent with active industrial uses. The sides of the EW contain hardened shorelines with extensive overwater structures, commercial and industrial facilities, and other development. Thirty-nine outfalls discharge into the EW, including 36 storm drains (SDs), one combined sewer overflow (CSO), and two CSO/SDs.

Due to the historical activities around the waterway, human health and ecological risks from contaminated sediments in the EW persist at levels that warrant action under federal and state laws. Risks to people are highest from eating resident seafood. Lower, but still significant, health risks to people come from sediment contact while clamming and net-fishing. Benthic invertebrates and some resident fish species are also at risk. The primary contaminants of concern (COCs) contributing to human health and ecological risk in the EW sediments include polychlorinated biphenyls (PCBs), arsenic, mercury, dioxins/furans, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

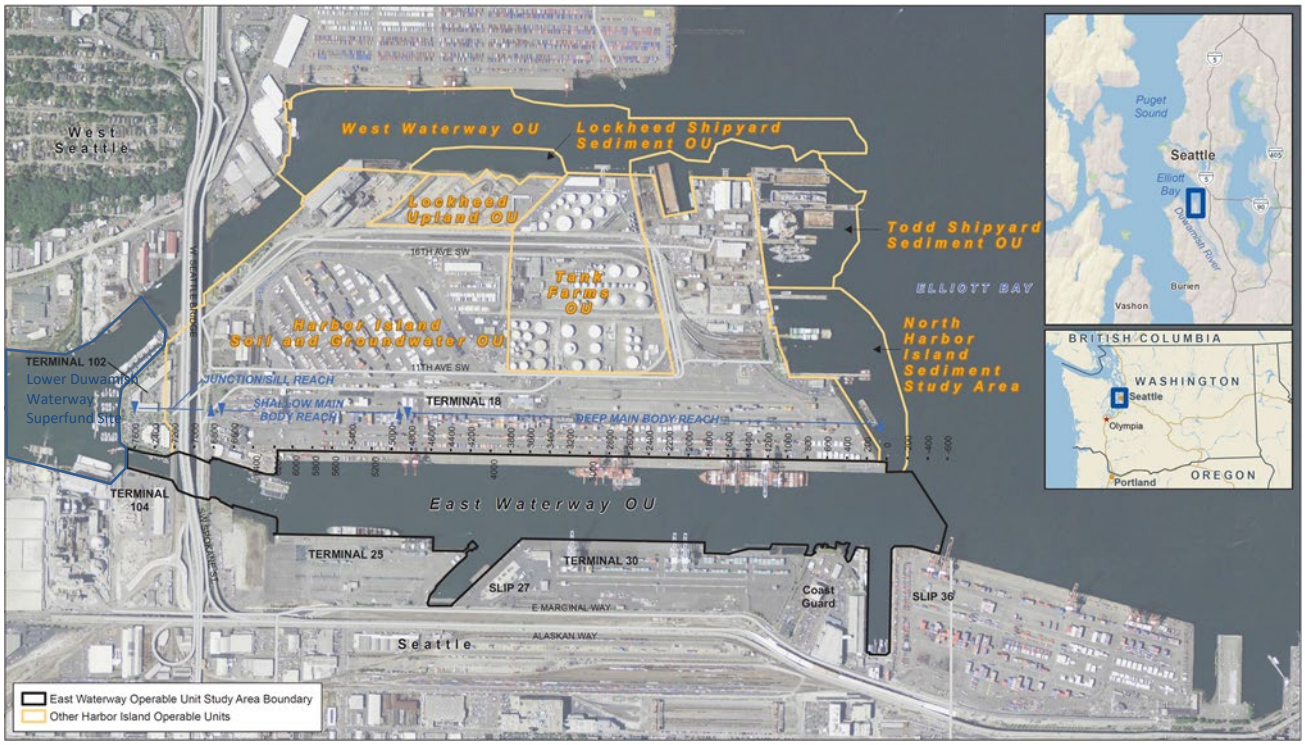


Exhibit 1. Location of East Waterway Operable Unit

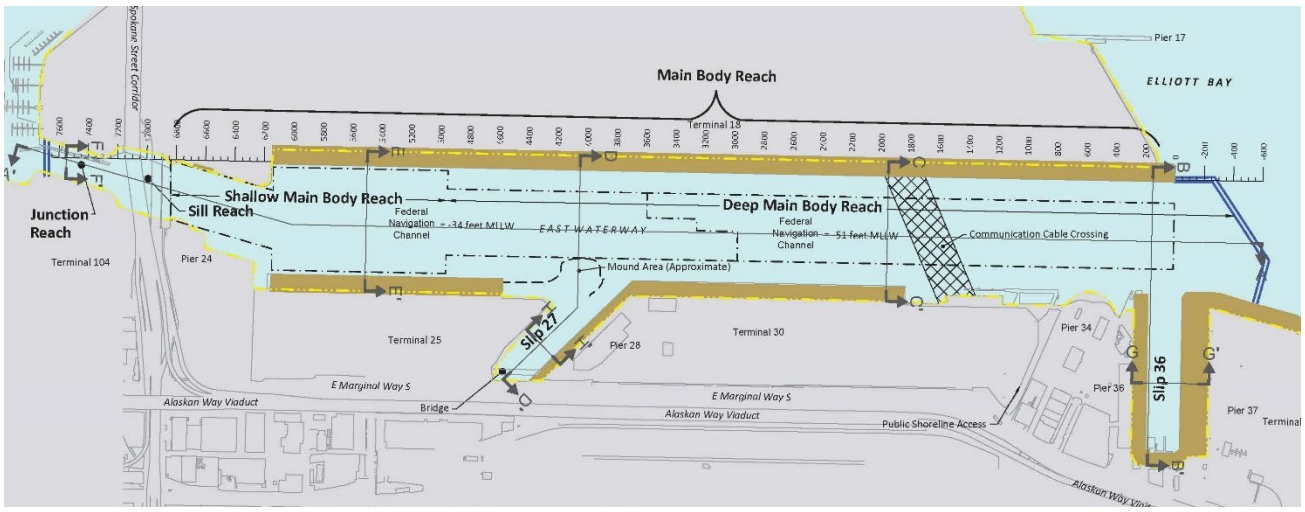


Exhibit 2. Main Featurs and managment areas within the EW. Note: Brown shaded areas are underpier areas. Numbers along western shore refer to Port of Seattle designated locations.

The Potentially Responsible Parties (PRPs: City of Seattle (City), King County (County), and Port of Seattle (Port)) are currently finalizing the feasibility study. The FS evaluated 9 cleanup alternatives with costs ranging from $950,000 to $411,000,000. All alternatives rely mainly on dredging to be compatible with the need to maintain the channel depth for navigation, including possible future deepening of the channel.

The Preferred Alternative is tentatively identified as a hybrid combination of Alternatives 2B(12) and 3B(12) from the Feasibility Study. Key elements of the Preferred Alternative are described below.

1. Main Channel Area: The Preferred Alternative relies primarily on dredging in the main channel area. Dredging removes the greatest mass of contaminant, is highly permanent, provides greater certainty in future remedy performance and is compatible with the current and future use of the waterway.
2. Sill Reach: For the shallow sill reach at the south end of the site, a 9-inch ENR layer is proposed because overwater structures present significant challenges to dredging and this area is not used for navigation.
3. Under-Pier Areas: *In-situ* treatment (most likely with activated carbon) will be used to address under-pier hot spots followed by the application of ENR.

The Preferred Alternative addresses all areas with PCB concentrations greater than 12 mg/kg organic carbon (OC). All alternatives use a combination of active cleanup and natural recovery to achieve risk-based or natural background-based remediation goals as required by state law. Approximately 100 acres of the waterway would be dredged, 7 acres capped, and 13 acres would receive ENR and in-situ treatment. The total dredging volume is estimated at 960,000 cubic yards, with a total cost of approximately $290 million.

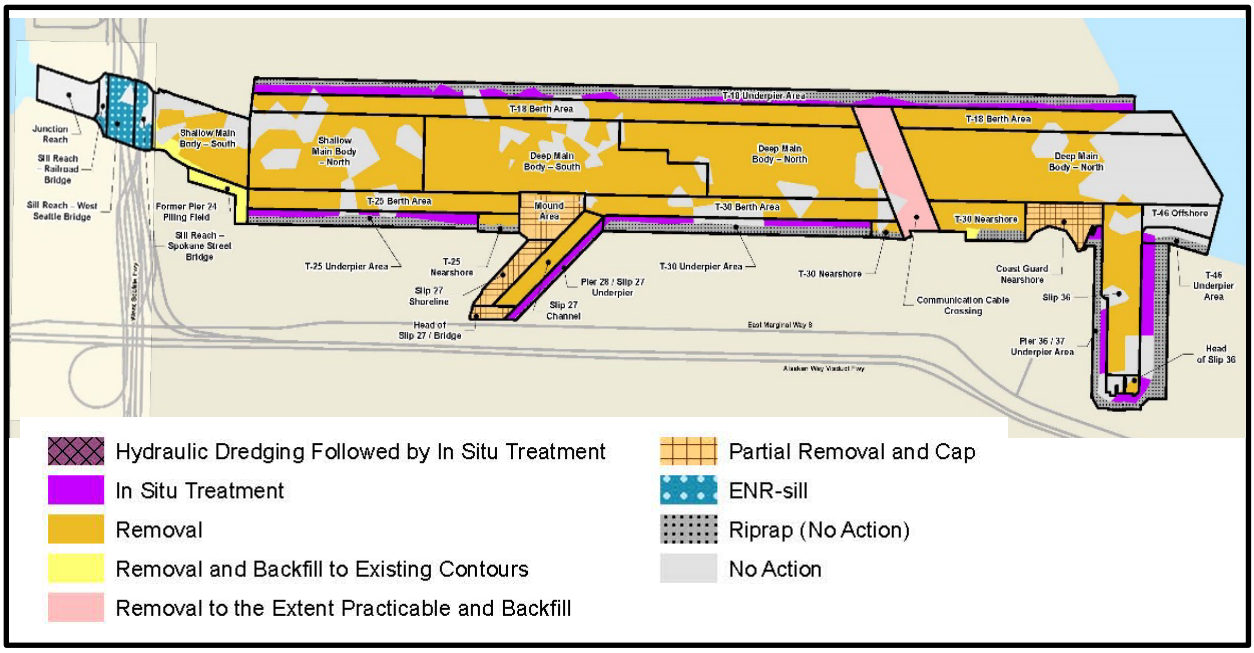


Exhibit 3. EPA's Preferred Alternative

1. CONTROL SOURCES EARLY

EPA and the EWG have been conducting source control programs to limit the primary lateral loads to the EW. Source tracing and control efforts include ongoing source tracing sampling, operating and maintaining storm drain and combined sewer overflow (CSO) systems, cleaning solids from storm drains and CSOs, complying with NPDES permits, implementing County and City CSO Control Plans, inspecting local businesses and implementing BMPs, and conducting upland cleanups. Empirical data and modeling efforts suggest that the effects of lateral loadings should be localized for current and future loading from lateral sources (e.g., storm drains and CSOs).

A. Briefly identify all significant continuing sources of sediment contamination at the site. For each continuing source, briefly indicate source control actions being taken or to be taken, the expected time to complete these actions, who will undertake them, and how continuing sources are being monitored.

Potential sources of contaminants from media such as air, soil, groundwater, and surface water or from impervious surfaces may migrate to the EW through various pathways (summarized in Attachment 1). The potential ongoing sources and pathways to the EW include the following sources:

- Lateral loads are a primary source to the waterway and includes direct discharge into the EW (e.g., CSOs, stormwater, or sheetflow from properties immediately adjacent to the waterway);
- Groundwater discharge (including tidally influenced groundwater discharge);
- Surface water inputs and sediment transport from upstream sources.
- Spills and/or leaks to the ground, surface water, or directly into the EW;
- Bank erosion; and,
- Abrasion and leaching of treated-wood structures.

Source control has been ongoing throughout the watershed. The majority of the source control has been performed under CERCLA, NPDES (e.g., for stormwater and CSO discharges), and Model Toxics Control Act (MTCA) for state-led upland cleanup sites adjacent to the EW.

East Waterway Source Tracing Activities: The City, County, and Port conduct source tracing and identification sampling to support the EW source control efforts. Source tracing sampling, including evaluations of TSS, and contaminant concentrations in storm drain and CSO solids is designed to identify potential sources by strategically collecting samples at key locations within the storm drainage and combined sewer service areas. Source tracing and source control efforts will continue through remedy implementation to minimize potential recontamination from direct discharges from stormwater outfalls and CSOs.

CSO Control Programs: CSO control programs by the County and City under the NPDES program (and consent decrees) has reduced the number of CSO connections to the EW and the number of events and event volumes. Under permits, the County and City provide the State monthly monitoring reports that include number of events and volumes and discuss efforts to reduce CSO discharges. In addition, long-term CSO reduction plans are required, including implementation of further controls on released volumes, decreased released solids and floatables, and O&M programs**.**

Operations and Maintenance Programs: The County, City, and Port each implement operation and maintenance program for drainage and wastewater systems. Catch basins in the drainage system are inspected annually and cleaned when there is excessive sediment accumulation, preventative maintenance programs, and working with businesses/tenants to implement BMPs to limit inputs to drainage systems.

Compliance and Inspection Programs: The Port, County, and City conduct various inspections/site assessments, based on their applicable regulatory authority, to enhance or assess compliance of permitted dischargers. The programs inspect industrial waste systems, identify and prioritize site for actions, including on-site storm drains that require cleaning, appropriate spill prevention/control programs, and proper training. These programs will continue during and after remediation. The continued inspection and assessment of businesses and tenants operating in the EW basin to enforce or enhance compliance with source control requirements through the implementation of appropriate BMPs reduces recontamination potential.

NPDES: NPDES discharges are generally administered by Ecology, although USCG discharges are administered federally. NPDES-permitted discharges to the EW include industrial and municipal stormwater, stormwater originating from certain construction projects, and County and City CSOs. Regular monitoring and reporting is conducted as part of these programs. The continued implementation of permitted discharges requires the integration of pollutant-reducing best management practices (BMPs).

Municipal Stormwater Management: Both the City's and the Port's municipal stormwater permits require development of a stormwater management plan to meet CWA and state water quality requirements. These programs include source control and pollution prevention, for existing and new development, the implementation of BMPs for new construction, including programs to detect, remove and prevent illicit connections to storm drain systems. The Port of Seattle requires compliance with O&M for all tenants.

Site Cleanup and Associated Programs: Upland soil and groundwater adjacent to the EW have been cleaned up and are monitored under Ecology-administered (MTCA) and EPA-administered (CERCLA) programs. Completion of groundwater monitoring programs will verify the protectiveness of upland remedies at state and federal cleanup sites with respect to EW sediment recontamination. Further evaluation of USCG property bank soil and groundwater quality will minimize the recontamination potential in the EW sediments in this area.

Upstream sediments have been, and will be, cleaned up under CERCLA, MTCA, and Resource Conservation and Recovery Act (RCRA) administration. The LDW cleanup and source control activities may reduce the potential for recontamination of EW sediments from ongoing upstream inputs. Timing of the LDW cleanup will be considered as part of source control sufficiency for the EW.

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Other programs: Spill response, air quality programs, creosote structures removal programs, and bank stability.

B. Where there is uncertainty about the timing or effectiveness of source control actions, briefly describe:

1. How the potential for recontamination has been considered in the selection or development of the proposed remedy.

Understanding ongoing sources of contamination and their potential to recontaminate sediments is an important consideration for the cleanup of the EW. As such, a source control evaluation was conducted as part of the remedial investigation and feasibility study. The goals of the source control evaluation included the following:

- Identifying potential sources of contamination to EW sediments;
- Understanding the potential for these sources to recontaminate the EW sediments;
- Assessing the role of ongoing sources on the CSM for the EW;
- Defining a process for identifying source control data gaps, and identifying a process for collecting relevant field data, if necessary;
- Providing a basis for the evaluation of potential sources through efforts such as inspections, investigation, or other actions and identifying the processes and authorities for source control activities in the EW area; and,
- If applicable, a prediction of potential recontamination and its effect on a cleanup decision

Upstream inputs and direct discharges (lateral loads) are the predominant source of sediment inputs to the EW. Both pathways were examined for recontamination potential. The remaining pathways listed in Item 1A were determined to be incidental and localized. Most of these pathways are episodic (e.g. spills and abrasion of treated-wood structures, or highly localized (e.g. groundwater discharge, bank erosion, and leaching of treated-wood structures) and were not further evaluated for recontamination potential.

<u>Direct Discharge and Upstream Inputs</u>: A grid model was used to evaluate the recontamination potential of nine COCs within the EW from direct discharge and upstream inputs. The grid model assumed current solids and chemical loads for years 1 through 10 post-construction, and assumed reduced loads (after additional control of sources) for years 11 through 40 post-construction (FS Section 5.4 and Appendix J of the FS). Surface concentrations were based on initial deposition patterns predicted by the particle tracking model, and did not take into account mixing or spreading of deposited sediments due to vessel operations in the EW (e.g., propwash).

COCs that may have an increased potential to recontaminate in specific areas include BEHP, 1,4-dichlorobenzene, mercury, and dioxins/furans, generally in localized areas near specific outfalls. Modeled concentrations for 1,4-dichlorobenzene are a result of conservatively using elevated measurements in the modeling dataset, which are more representative of a source that has since been controlled; therefore, exceedances are not likely to persist. Mercury's potential exceedance is predicted to occur in a single grid cell in the EW, where there are only a few samples with relatively high concentrations and variability. Because BEHP and dioxins/furans are ubiquitous components of PVC plastics and combustion processes, respectively, marginal remedial action limit (RAL) exceedances may occur in the immediate vicinity of outfalls, consistent with other urban areas. It is anticipated that these areas will be considered during the design phase as areas that may require additional source evaluation and control and targeted monitoring following remediation.

2. **Whether the proposed sediment remedy is expected to be beneficial if source control is not effective or not complete by the time the proposed sediment remedy is planned to be implemented.**

   It is important to note that in localized areas, some recontamination may occur even with aggressive source control because of the difficulty in identifying and completely controlling all potential sources of certain ubiquitous contaminants that are widely released by urban activities (e.g., phthalates). Other contaminants with the possibility of exceeding action levels near outfalls based on the feasibility study analysis include 1,4-dichlorobenzene, dioxins/furans, and mercury.

   For the EW, recontamination of site sediments will be controlled to the extent practicable under existing source control efforts and authorities. The goal is to limit sediment recontamination that exceeds location-specific standards, where feasible. Delaying sediment cleanup until all sources have been identified and controlled, regardless of their contribution in terms of contaminant loading, may delay achieving many of the benefits that sediment cleanup alone can accomplish.

2. INVOLVE THE COMMUNITY EARLY AND OFTEN.

Stakeholders were engaged as early as the development of the scope of work and through the SRI and FS. There is general support for the project by the surrounding community, which is largely represented by the marine-related businesses, Tribal fishers, and recreational users. There are no residential neighborhoods in the immediate vicinity of the EW. There was a high level of interest in the Lower Duwamish Waterway Superfund site record of decision; efforts were made to be consistent in developing the preliminary remedial goals and remedial action levels for the EW. The baseline risk assessments evaluated potential site uses by workers and local populations, including tribal members and Asian and Pacific Islanders (API). These risk results have been factored into developing the long-term cleanup goals for the EW. Future uses by the business community were considered in the selection of the preferred alternative. EPA will consider input from the affected community on the FS and when developing the Proposed Plan.

A. Briefly describe the role of the community in the RI/FS and the mechanisms that were used to solicit effective involvement of a variety of community members in sediment-related issues.

The community surrounding the EW is dominated by marine-related industries or marine dependent businesses that lease property from the Port of Seattle. The Port is the primary land owner in the areas adjacent to the EW, is a member of the EWG, and has been involved in the development of the RI and FS. Land use and water user surveys have been used to develop the future uses of the waterway and incorporated into the selection of the proposed alternative.

The EW is within the usual and accustomed (U&A) fishing area for the Muckleshoot Indian Tribe and the Suquamish Tribe. Both tribes operate commercial and ceremonial fin-fish and shellfish fisheries in the waterway. The Tribes have been consulted throughout the process. Estimates of human health risk have been based on tribal subsistence fish consumption and net-fishing exposures scenarios. The Tribes support the cleanup provided is consistent with the continued support of the tribal fisheries.

King County, City of Seattle and Port of Seattle comprise the East Waterway Group (EWG) and have been conducted the supplemental remedial investigation (SRI) and FS. The EWG will continue to be involved with the project and will conduct the pre-design sampling and analysis.

Region 10 has used email, fact sheets, signage, public meetings, and a web site to communicate with the community and local businesses. A site repository is located at the local library in Seattle.

After the release of the feasibility study documents, the Proposed Plan will be prepared in early 2018 for public release. At that point, greater public interest is expected.

B. Briefly describe how local, societal and cultural practices were considered in:

1. **The human health risk assessment (e.g., local, recreational use of the water body, local fishing practices).**

   The Site is within the Usual and Accustomed (U&A) fishing ground for the Muckleshoot and Suquamish Tribes. Potential exposure routes under this scenario include ingestion of contaminants that bioaccumulate in fish/shellfish tissue, and incidental ingestion of and dermal contact with sediment during net fishing and clamming. Tribal exposure scenarios have been used for setting sediment cleanup goals, including both shellfish consumption and direct sediment contact pathways (netfishing and shellfish harvesting).

   The HHRA also considers site use by Asian and Pacific Islanders, using seafood consumption surveys conducted by EPA for API in the King County area (EPA 1999b).

2. **The selection or development of the proposed remedy (e.g., current and future uses of the water body).**

   Local, societal and cultural practices at the Site involve commercial navigation, limited recreational use, and tribal subsistence fishing. The preferred remedy was selected to ensure current navigation practices are not impeded upon and future waterway development is not restricted. Each of the alternatives take into account fish windows that avoid construction activities during migration of threatened or endangered fish species.

Additionally, the construction time lines avoid construction during traditional tribal fishing periods.

C. Briefly describe the major ways the proposed sediment remedy is expected to affect the local community during remedy implementation.

There are limited recreational activities that include boating, kayaking, fishing, and beach play. There is one public park, Jack Perry Memorial Park and the Spokane Street Bridge in the southern portion of the waterway. These areas would have to be closed to the public during construction.

As indicated above, the tribal fishing windows are currently incorporated in the construction time lines and should not be impacted during implementation.

The greatest impact will be to businesses that utilize the channel for shipping and navigation purposes. Restrictions to boat traffic and continual coordination with those businesses during construction will be required.

D. What is the expected level of community support for the proposed sediment remedy? Briefly identify any aspects that are expected to be of great concern and the expected concerns have been addressed or considered.

Commercial activities associated with shipping and the use of adjacent terminals, docks and piers are the dominant waterway users. There is general support for the project. For commercial waterway users the potential for waterway use restrictions are likely to be the biggest concern, including the potential economic impacts during construction.

The Tribes have been consulted with throughout the process. There is support for the cleanup project provided it is consistent with continued support of Tribal fisheries. The HHRA has used Tribal risk scenarios to ensure that Tribal fisheries are supported in the future. As indicated previously, construction timelines have included windows for Tribal fisheries.

The Asian and Pacific Islander community also fishes in the waterway and may object to potential short-term closures during implementation.

Recreational use of the waterway is limited to Jack Perry Memorial Park and Spokane Street Bridge. Concerns by the general public are likely to be associated with potential short-term closures of intertidal areas and fishing piers, noise and air-quality impacts during construction and any economic impacts.

3. Coordinate with States, Local Governments, Tribes, and Natural Resource Trustees.

The Muckleshoot Indian Tribe and Suquamish Tribe, DNR, and NOAA have all been closely involved in the studies completed to date on the EW. EPA will continue to share key concepts and issues related to the cleanup with NOAA, the Tribes, and DNR. The County, City, and Port are members of the EWG and have developed the SRI and FS in coordination with EPA.

A. Briefly describe the major sediment-related issues in which state and local governments have been involved at the Site. Briefly identify any aspects that are expected to be of great concern and how the expected concern has been addressed or considered.

The Washington State Department of Ecology has been actively involved in discussions about the application of the State promulgated Sediment Management Standards as an ARAR throughout the process, as well as coordinating cleanup activities in adjacent properties. The State is also the lead agency for source control for upstream sources (Green River and Duwamish River).

Three issues specific to the State SMS include sediment recovery zones (SRZ), natural

background for arsenic, and the development of regional background concentrations. These issues have been resolved through the development and finalization of the FS and are as follows:

- Under the SMS, sediment recovery zones (SRZs), can be designated when cleanup goals are unlikely to be met within the timeframe designated in the order. SRZs allow for an extension of the recovery period, but also require monitoring and demonstration of progress towards remedial goals. SRZs are included in the FS and are a potential option for the EW.
- The State of Washington has established natural background concentrations of COCs using the 90/90 upper threshold limit (UTL) of the mean. For arsenic, the State background concentration is 11 mg/kg dw. EPA Region 10 uses a 95% upper confidence limit (UCL) to determine background concentrations and for As in the EW, the 95UCL is 7 mg/kg dw. Furthermore, Region 10 does not support the technical basis for using of the 90/90 UTL to establish background concentrations. Because the State background concentration of As is higher than the EPA derived value, the State's value is not considered an ARAR and is not used to set the PRG. The 7 mg/kg dw PRG is consistent with the cleanup level at the upstream LDW site.
- The SMS allows for the determination of a regional background concentration of COCs. The regional background concentration may then be used in lieu of a natural background concentration for deriving a cleanup level provided that:
    - It is not possible to achieve the natural background concentration, or a natural background value does not exist, and;
    - A regional background has been established and agreed to by USEPA.

  The potential future use of a regional background value has been raised by the EWG for arsenic since long-term modeling predicts an arsenic concentration above the PRG. However, no regional background concentration for arsenic exists at this time for the East Waterway. Therefore regional background has not been considered in the FS.

  Should a regional background for arsenic become established in the future, EPA Region 10 will evaluate the method and associated data to determine whether to adopt the regional background concentration for the EW.

King County, the City of Seattle, and the Port of Seattle comprise the East Waterway Group and represent the PRPs and land owners along the East Waterway. The EWG has prepared the SRI and FS documents. The EWG is also responsible for source control activities for lateral sources adjacent to the EW.

The State Department of Health has issued a Fish Consumption Advisory for the consumption of all resident fish and shellfish from the East Waterway. This advisory includes the Lower Duwamish Waterway as well as the East Waterway.

B. For sites that include water bodies where total maximum daily loads (TMDLs) are being or have been developed. Briefly describe the coordination efforts with the state and with EPA's water program. Identify any aspects of the TMDL that were considered in selection of the proposed remedy.

There are no TMDLs associated with the East Waterway or Elliott Bay.

C. If there are Tribal interests at the site, briefly identify any aspects of the proposed sediment remedy that are expected to be of great concern and the how the expected concern has been addressed or considered.

As noted previously, the EW is within the U&A fishing grounds for the Muckleshoot and Suquamish Tribes. The Tribe has expressed their desire for a remedy that will support lifting restrictions on seafood consumption. However, the Tribe understands that the risk-based concentration for PCBs will not likely be met because it is below the Puget Sound natural background concentration.

There may be short-term considerations during construction related to Tribal fishing. The current construction schedules do not allow for construction during the traditional tribal fishing periods. However, EPA and the Tribe may wish to negotiate longer construction windows to facilitate a shorter overall construction period.

D. If there are Natural Resource Trustee interests at the site, briefly identify the major areas of coordination related to the sediment response action. Are trustee restoration activities expected concurrent with or following the Superfund action?

Region 10 has provided regular updates to the Natural Resource Trustee Council for the EW, which includes tribal (the Suquamish and Muckleshoot Tribes); federal (National Marine Fisheries and U.S. Fish and Wildlife Service) and state (Washington State Departments of Ecology, Natural Resources, and Fish and Wildlife) resource agencies. These agencies have been provided copies of site investigation reports and EPA has accepted and incorporated trustee comments as appropriate.

Concurrent trustee restoration activities are not currently scheduled; however, restoration activities may be identified during design or following construction.

4. DEVELOP AND REFINE A CONCEPTUAL SITE MODEL THAT CONSIDERS SEDIMENT STABILITY

Empirical data and modeling have been used to develop a CSM of the EW, which is summarized in Section 2 of the FS and described in detail in the SRI (Windward and Anchor QEA 2014). The CSM indicates that the EW is a net depositional system, with areas subject to episodic scouring as a result of vessel activity within routine operating parameters, but not from estuarine flows. Potential vessel scour depths were considered in developing the remedial footprint, assigning remedial technologies, and predicting the performance of remedial alternatives.

A. Attach a copy of the Conceptual Site Model (e.g., one or more diagrams or charts, not numerical models) for sediment that identifies contaminant sources, contaminants of concern, affected media, existing and potential exposure pathways, and human and ecological receptors that may be threatened.

Please refer to these figures: Exhibits 4 through 7.

Key points of the site conceptual model are summarized below:

- Sediment sources to the EW include the upstream sources (Green River, LDW bed and bank sediments, and LDW lateral load sediments), downstream sources (Elliott Bay), and local sources (lateral sources that drain directly to the EW).
- Riverine and tidal currents in the EW are not expected to cause significant erosion of in situ bed sediments, as the maximum predicted bed shear stress during a 100-year high-flow event modeled to be less than the mean critical shear stress of the bed sediments. Modeled bed shear stress due to large vessel operations (e.g., propwash) in northern portions of the Deep Main Body Reach is significantly greater than bed shear stress due to natural forces and is regularly above the critical shear stress for bedded sediments. Consequently, these areas are likely subject to episodic erosion and re-suspension of bed sediments due to propwash. The Shallow Main Body Reach and southern portion of the Deep Main Body are also subject to impacts from vessel operations; however, the vessels that operate in these areas are smaller in size and operate less frequently than in the northern portion of the Deep Main Body Reach. Therefore, these areas may be subject to occasional erosion or re-suspension of surface sediments due to propwash.
- Historical sources from industrial activities have been identified and controlled to some extent. Ongoing potential sources of contaminants to sediment from media such as air, soil, groundwater, and surface water or from impervious surfaces may migrate to the EW. Contaminated sediment serves as a significant source in the bioaccumulation pathway of contaminants to benthic invertebrates and resident fish.
- Potentially exposed populations evaluated for human health impacts include Tribal, Asian and Pacific Islanders and recreational fishers exposed to contaminants via seafood consumption, direct contact with sediments, direct contact with sediment during net fishing, and surface water exposure via swimming.
- The ecological receptors of concern include the benthic invertebrate community; crabs; fish species of English sole, brown rockfish, and juvenile Chinook salmon; and wildlife species of pigeon guillemot, osprey, river otter, and harbor seal.

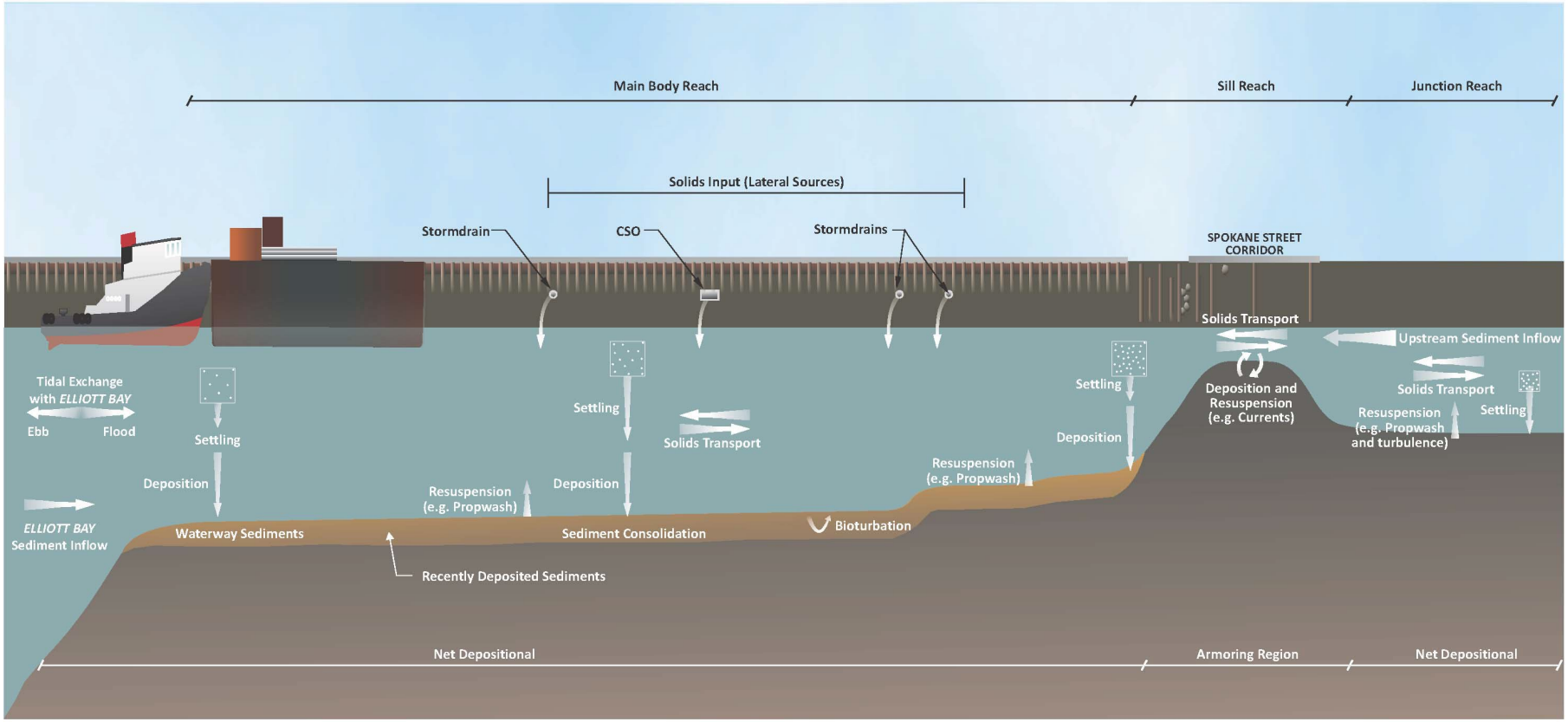

Exhibit 4. Physical CSM for East Waterway.

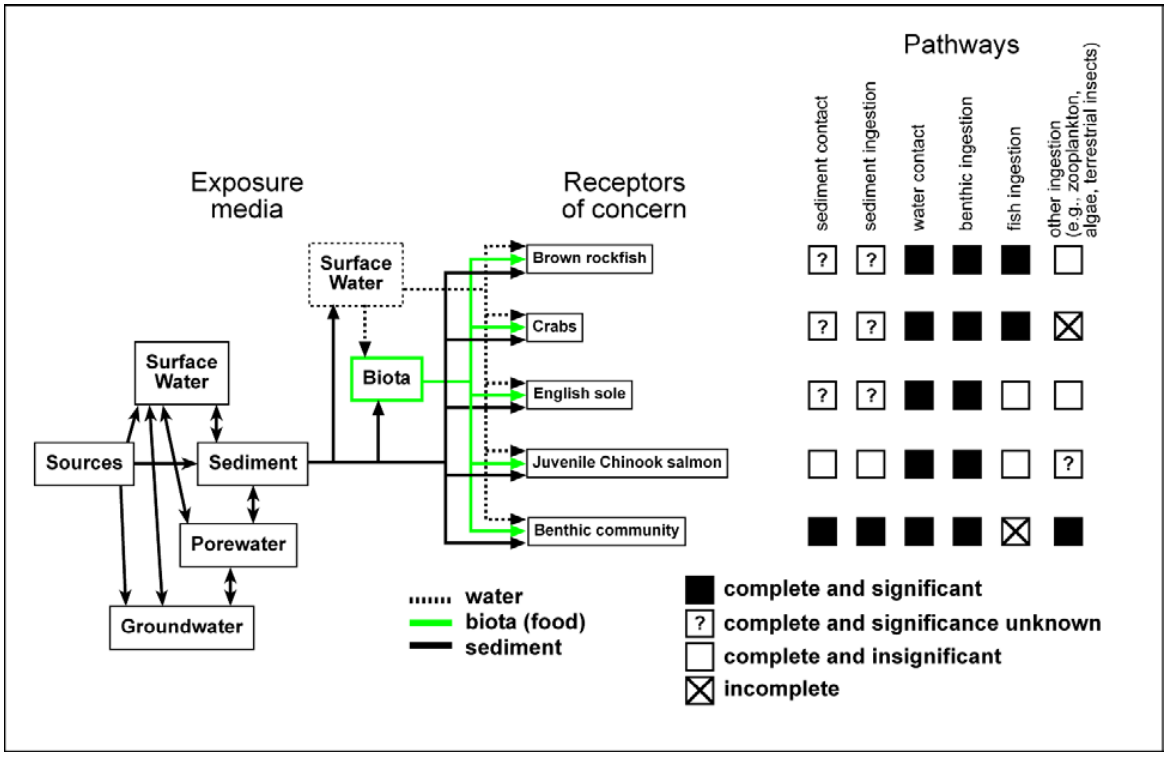

Exhibit 5. Aquatic Conceptual Site Model for East Waterway.

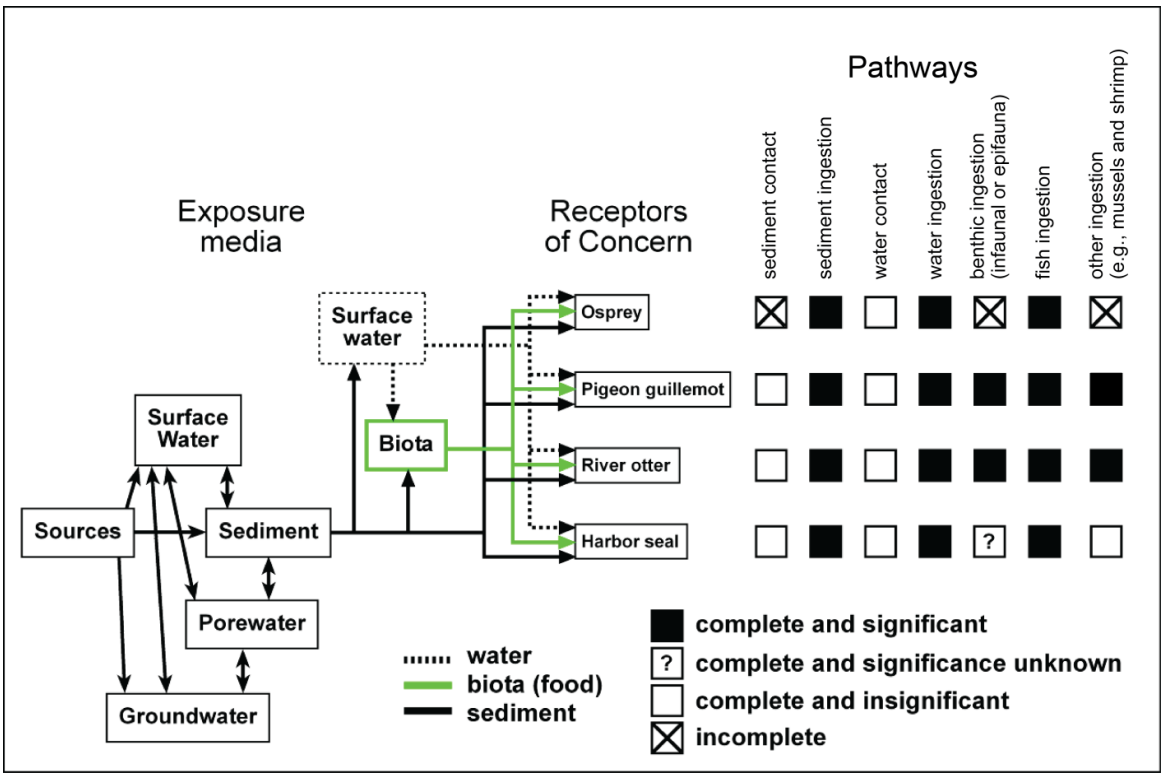

Exhibit 6. Conceptual Site Model for Wildlife in the East Waterway.

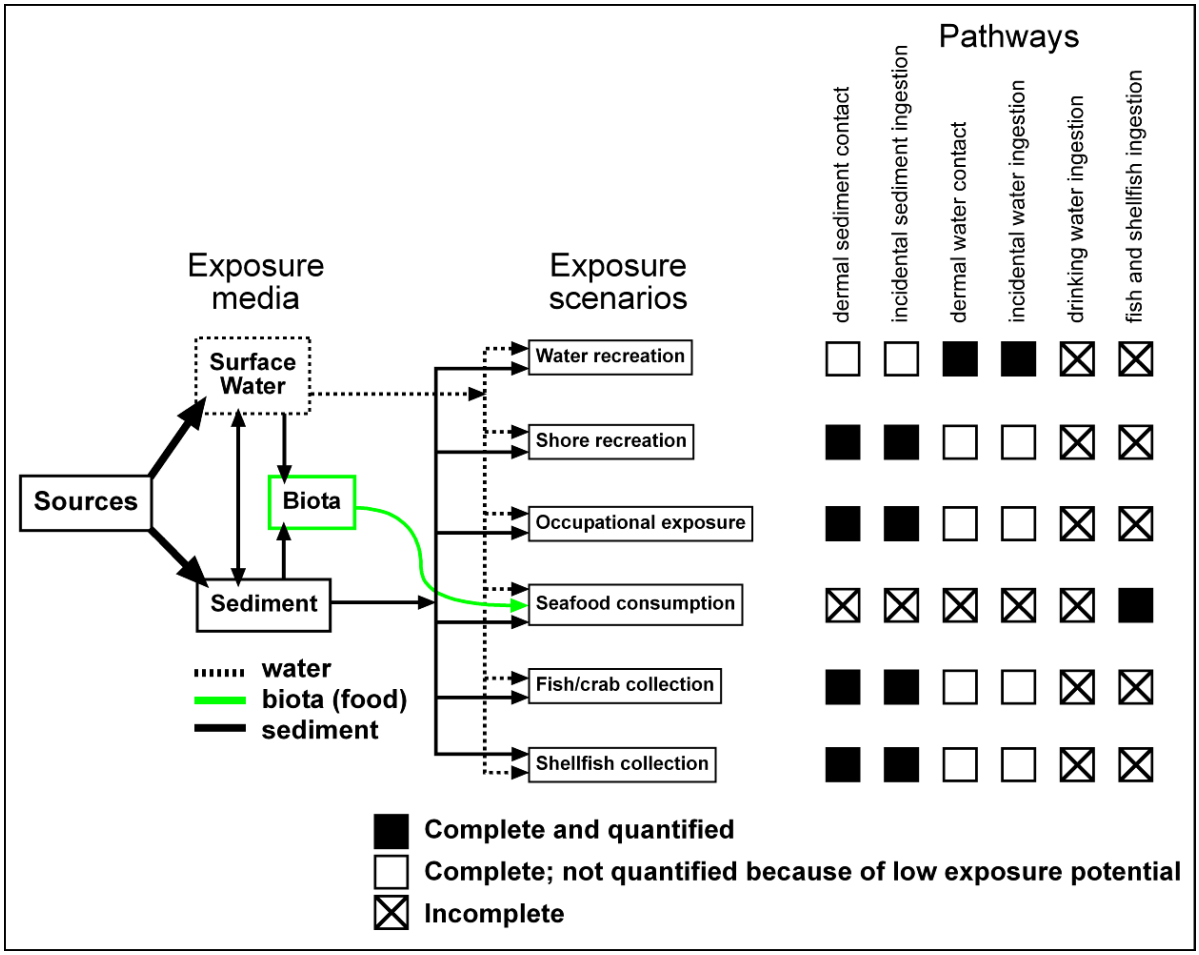

Exhibit 7. Conceptual Site Model for Human Health

B. Identify the natural and man-made disruptive forces that were considered and how they were considered when evaluating sediment alternative. Where appropriate, identify the intensities or recurrence intervals of the forces (e.g., hurricane rating, flood recurrence interval) and briefly explain why these intensities or recurrence intervals were chosen.

As noted previously, riverine and tidal currents in the EW are not expected to cause significant erosion of in situ bed sediments. Bed shear stress due to large vessel operations is estimated to be the most significant of disruptive forces.

Erosion and resuspension due to prop-wash was included in the physical CSM and was modeled for both vertical mixing in the bottom sediments as well as lateral mixing along piers and docks. Maximum near-bed velocities were estimated to range from 3 to 11.4 ft/s. Propwash-induced bed shear stresses due to steady-state docking procedures estimated for all defined vessel operations and associated operational areas in the EW range from 2 to 23 Pa. Based on the scour evaluation, surface sediments within the waterway have the potential to be eroded due to vessel operations at varying depths ranging from 0.3 to 4.7 feet (based on both typical and extreme vessel operations) throughout the majority of the EW. Scour estimates were calculated using steady state assumptions, and represent conservatively high estimates of scour based on defined vessel operations.

Additional modeling was conducted to determine the impacts of horizontal mixing from bow thrusters or other influences during docking procedures. The volume of material exchanged was assumed to be 25% of the total volume of underpier sediments over a five year period. Volumes were estimated based on the length of the pier face within EW that is adjacent to a vessel operational area predicted to have large propwash scour depths.

5. USE AN ITERATIVE APPROACH IN A RISK-BASED FRAMEWORK.

A. Briefly describe any major ways in which an iterative approach was used at the site. (We define "iterative approach" broadly to include approaches that incorporate testing of hypotheses and conclusions and foster re-evaluation as new information is gathered.)

The EW cleanup process will do the following:

1. Continue source control efforts in coordination with EW and LDW cleanup activities
2. Address uncertainties and provide flexibility in the design elements as more data become available. Use the results of previous actions, including actions at adjacent sites to inform further sediment cleanup.
3. Monitor performance and changing conditions in both the remediation and source control efforts.
4. Implement contingency actions that may become needed over time.

A long-term monitoring plan will be established with metrics and analyses that meet clearly articulated data quality objectives. Baseline monitoring will be conducted prior to beginning the initial remedial activities to establish a benchmark for evaluating the effectiveness of the remediation. Collecting monitoring information during and after cleanup will help evaluate the effectiveness of the selected remedial alternative, and trigger the planning and execution of

contingency actions as needed. Because remediation and source control efforts will take years to occur, and biological response may take even longer, monitoring the changes in contaminant inputs and responses of various media in the EW will be important to help determine when and to what extent contingency actions may be needed. Contingency actions may include more sediment remediation or source control efforts.

In the EW, adaptive management could be used to maximize the rate at which site-wide risks are reduced, while minimizing the uncertainties associated with remediation. In particular, remediation of underpier sediments, which represent a relatively small area (12 acres) but some of the higher COC concentrations, have more uncertainty associated with performance and/or implementability for all retained remedial technologies (MNR, in situ treatment, and diver-assisted hydraulic dredging). In particular, diver-assisted hydraulic dredging is more hazardous for worker health and safety and likely to have high costs and short-term impacts that are disproportionate to the long-term benefits (i.e., reduction in risk) due to the significant amount of contaminated sediment that will remain following diver-assisted dredging. For these reasons, adaptive management principles will be particularly important for remediating underpier sediments in effective and practicable ways. If monitoring indicates that the preferred underpier remedy of in-situ treatment is not effective, diver-assisted dredging may be considered as a contingency.

EPA will evaluate the effectiveness of the selected remedial alternative every 5 years subsequent to completion of remediation. The 5-year reviews will integrate comprehensive evaluations of the seafood consumption advisories, outreach and education programs, source control work, remedy effectiveness, and changes in overall waterway health. These periodic reviews can be used by EPA in conjunction with the performance monitoring program to identify the need for any additional course corrections (e.g., contingency actions, review endpoints, modify technologies, or conduct more monitoring) in the cleanup.

B. Briefly describe any early or interim actions planned or implemented at the site that addresses threats from contaminated sediments.

In 2005 the Phase 1 Removal Action completed dredging of 240,000 cubic yards of sediment in the southern portion of the Deep Main Body Reach of the EW. No additional early or interim actions are planned.

C. If the proposed sediment remedy will be implemented in phases or is part of a larger phased approach to the site as a whole, briefly describe the phases.

The EW is part of the larger Harbor Island Superfund site and is downstream of the Lower Duwamish Waterway Superfund site. The cleanup of the EW will be coordinated with key phases of the LDW cleanup and associated watershed source control projects.

The EW cleanup will occur over 9-13 years, depending upon the Alternative selected (10 years for the current proposed alternative). Due to in water construction window restrictions for protection of endangered species, along with consideration of tribal net fishing, construction may occur over an estimated 10 years in phases that coincide with in water construction windows. However, if the EPA is able to negotiate a longer window for construction with the Tribes, the construction time could be reduced by approximately one-third.

6. CAREFULLY EVALUATE THE ASSUMPTIONS AND UNCERTAINTIES ASSOCIATED WITH SITE CHARACTERIZATION DATA AND SITE MODELS.

The SRI and FS has been completed over the past 8 years and includes extensive site characterization and models for evaluating sediment stability and long-term recovery in the EW. Key uncertainties have been considered in evaluating the alternatives, and the effects of these uncertainties have been discussed in the evaluation of alternatives.

A. Briefly identify the most important continuing uncertainties associated with site characterization data and, where applicable, with qualitative or quantitative models, including input parameters, which were important:

1. To the human health and ecological risk assessment

There are uncertainties associated with the risk estimates for each exposure scenario in the EW HHRA. For example, the RME exposure assumptions were developed to result in high-end estimates of the risks associated with the EW. This conservative approach ensures that resulting risk-based threshold concentrations are protective of the most sensitive populations.

Risk estimates were highest for the seafood consumption scenarios, but the uncertainties associated with these risk estimates are also very high. Current fish consumption rates are likely to be suppressed due to the fish consumption advisories in place for resident fish and shellfish. Tribal and API seafood consumption rates that were used in the EW HHRA, although based on well-designed consumption surveys, were not specific to populations who primarily fish in the EW. Although the collection and consumption of seafood from the EW are known to occur [a creel study by King County (1999a) identified the Spokane Street Bridge on the EW as one of the more popular fishing locations along the shores of the Duwamish River and Elliott Bay]. Given the lack of EW-specific seafood consumption rate estimates, the risk-per-unit consumption for various seafood categories can be used by individual seafood consumers to better understand their risks.

2. To the evaluation of potential sediment remedies. Briefly explain how those uncertainties were accounted for (e.g., use of sensitivity analysis or reasonable conservative assumptions).

A sensitivity analysis was performed for the FS to understand the impacts of key parameters on model predictions of the performance of the alternatives in reducing COC concentrations immediately after construction and up to 40 years after construction. For Alternatives 2B(12) through 3E(7.5) (all of the action alternatives with the exception of Alternative 1A(12)), the range of predicted SWACs between the alternatives was smaller than the range of predicted SWACs between sensitivity runs for a single alternative, with no change in risk outcome for any sensitivity run.

Additional factors are factors important for managing uncertainty relative to the anticipated performance of the alternatives:

- Dredge residuals thickness, concentration, and distribution will vary as a result of quality and thickness of sediment being dredged, hydrodynamic and operational conditions during construction. The presence of dredge residuals will be mitigated to the extent practicable by using BMPs including the application of a Residual Management Cover (RMC) layer (10 cm sand layer) over all dredged surfaces to minimize the impact of residuals.
- Technical challenges associated with the technologies for remediating underpier areas are a key uncertainty in this FS.
    - The performance of MNR in underpier areas is less certain compared to the other remedial technologies; however, MNR poses very few technical challenges. MNR is not included in the preferred alternative.
    - The performance of *in-situ* treatment depends on site-specific physical and chemical factors, the constructability of the *in-situ* treatment technology (e.g. placing material on steep slopes or in difficult-to-access areas), and uncertainty related to sediment resuspension due to propwash. In-situ treatment will be overlain with ENR to control mobility. Post remedial monitoring will be used to ensure effectiveness, with diver-assisted dredging or other technologies considered as contingencies.
    - Diver-assisted hydraulic dredging is associated with large uncertainty with both performance and technical implementability. Performance is uncertain with respect to the quantity of contaminated sediment that will be left behind due to conditions under piers (e.g., riprap interstices and debris). Technical implementability is also uncertain with respect to the construction timeframe, costs, dewatering and management operations, and health and safety risks posed by this type of underwater construction. Under the preferred alternative, diver-assisted dredging will only be considered as a contingency measure.
- The performance of the remedial technologies outside of underpier areas also have uncertainties, which are mitigated by adaptive management, including:
    - Dredging results in the release of contaminants to the water column (which can maintain elevated fish and shellfish tissue contaminant concentrations over the short term) and dredge residuals to the sediment surface. Full removal of all contaminated sediment is not possible in many areas near structures, where setbacks and stable slopes required for structure protection will leave some contaminated sediments behind. RMC layers will be used to limit receptor exposure to dredge residuals.
    - Capping, ENR, and in situ treatment require ongoing monitoring and may need periodic maintenance. These uncertainties will be managed by the required monitoring, contingency actions, and repairs as needed. Cost estimates in this FS include the costs of these long-term management activities. These activities would be enforceable requirements under a Consent Decree (or similar mechanism), and EPA is required to review the effectiveness of their selected remedy no less frequently than every 5 years.

B. Identify any computer models used in the assessment of the site or evaluation of sediment alternatives. For each model or model group, indicate whether the model or model application was peer-reviewed and if so, briefly indicate whether that review was internal or external to EPA.

Exhibit 8. Models used for the EW

Model	Description	Peer Review? Internal or external?
Sediment Transport Model	Quantifies sediment loading from different sources to individual model grid-cell locations over time.	Informal; EPA and US Army Corps of Engineers
Particle Transport Model	Estimate the relative contribution and distribution of solids loads from lateral sources to overall sedimentation rates.	Informa; EPA and US Army Corps of Engineers
Bedload Composition Model	Calculates an expected COC concentration at individual model grid-cell locations in the surface sediment layer by using a simple mass balance formula. Outputs are used to evaluate recovery potential of sediments, identify and screen remedial technologies, and develop and evaluate remedial alternatives.	Informa; EPA and US Army Corps of Engineers
Gobas Food Web Model	Developed for PCBs to estimate the relationship between total PCB concentrations in tissue and sediment. Outputs were used to estimate risk based threshold concentrations in sediment and residual risk.	Informal; EPA and US Army Corps of Engineers
JETWASH	Simulates the velocity field created by propulsion systems and accounts for the interaction of the velocity jet with the sediment bed in order to predict prop-wash scour potential.	

7. SELECT SITE-SPECIFIC, PROJECT-SPECIFIC, AND SEDIMENT SPECIFIC RISK MANAGEMENT APPROACHES THAT WILL ACHIEVE RISK-BASED GOALS.

EW-specific risk-based goals have been developed. A range of remedial alternatives have been developed that consider location-specific uses, physical constraints, and the limitations of the remedial technologies. Finally, those alternatives have been compared to risk-based goals and background levels to help develop risk management approaches that include a range of actions. The action alternatives include a combination of technologies to look at the most effective ways to manage risk, and also include monitoring and adaptive management to maintain reduction in risks in the long-term.

A. List all alternatives that were evaluated for remediation of contaminated sediment at the site. If the list does not include some form of each of the three major sediment cleanup methods (i.e., capping, monitored natural recovery, dredging and/or combinations of these), then explain why the method(s) was not evaluated.

Each of the three major sediment cleanup methods was considered in the development of the remedial alternatives, including capping, monitored natural recovery, and dredging. These technology groups, as well as enhanced natural recovery and in-situ treatment were considered for both open-water and limited-access areas (areas underneath piers, bridges, and docks) and are summarized in a technology screening memorandum (Anchor QEA 2012) that is summarized in Section 7 of the FS.

A total of 16 remedial alternatives were initially developed by varying three components:

1) The remedial technology assignments in the open-water areas that are generally accessible to barge-mounted construction equipment;
2) The remedial technology assignments in areas with limited access to construction equipment, such as under piers; and
3) The RALs that result in variation of the remediation footprint.

Alternatives were screened down to ten representative alternatives for detailed analysis: the No Action Alternative and nine action alternatives.

All of the action alternatives rely primarily on removal (i.e., dredging) of contaminated sediment from the waterway because the sediment bed elevation within most of the waterway is at the depth needed for navigation. Therefore, other cleanup options, such as capping that would raise the sediment bed elevation, are precluded in much of the EW.

Remediation of difficult-to-access sediments (e.g., under piers) presents major technical challenges for cleanup of the EW; therefore, a range of technologies are evaluated specifically for the underpier areas. The range of technologies presented in the alternatives includes MNR, ENR, placement of in situ treatment material, and diver-assisted hydraulic dredging.

Technologies were assigned to construction management areas. The costs to implement the action alternatives range from $256 to $411 million dollars, and the estimated time to complete construction on active cleanup components ranges from 9 to 13 years.

The alternatives are as follows:

- The **No Action Alternative** provides a basis for comparison for the other remedial alternatives and is required by CERCLA
- **Alternative 1A(12)** employs open-water option 1 (removal with capping and ENR where applicable), restricted access option A (MNR in the underpier areas) and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 1B(12)** employs open-water option 1 (removal with capping and ENR where applicable), restricted access option B (in situ treatment in the underpier areas) and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 1C+(12)** employs open-water option 1 (removal with capping and ENR where applicable), restricted access ion C+ (diver-assisted hydraulic dredging followed by in situ treatment for total PCBs or mercury > CSL; in situ treatment elsewhere exceeding RALs in the underpier areas), and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 2B(12)** employs open-water option 2 (removal with capping where applicable), restricted access option B (in situ treatment in the underpier areas) and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 2C+(12)** employs open-water option 2 (removal with capping where applicable), restricted access option C+ (diver-assisted hydraulic dredging followed by in situ treatment for total PCBs or mercury > CSL; in situ treatment elsewhere exceeding RALs in the underpier areas), and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 3B(12)** employs open-water option 3 (maximum removal area with less capping, to the extent practicable), restricted access option B (in situ treatment in the underpier areas) and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 3C+(12)** employs open-water option 3 (maximum removal area with less capping, to the extent practicable), restricted access option C+ (diver-assisted hydraulic dredging followed by in situ treatment for total PCBs or mercury > CSL; in situ treatment elsewhere exceeding RALs in the underpier areas), and RALs that include 12 mg/kg OC for total PCBs.
- **Alternative 2C+(7.5)** employs open-water option 2 (removal with capping where applicable), restricted access option C+ (diver-assisted hydraulic dredging followed by in situ treatment for total PCBs or mercury > CSL; in situ treatment elsewhere exceeding RALs in the underpier areas), and RALs that include 7.5 mg/kg OC for total PCBs.
- **Alternative 3E(7.5)** employs open-water option 3 (maximum removal area with less capping, to the extent practicable), restricted access option E (diver-assisted hydraulic dredging followed by in situ treatment in the underpier areas), and RALs that include 7.5 mg/kg OC for total PCBs.

B. Describe the proposed sediment remedy for the site and how it relates to any other sediment operable units at the site.

The EPA Region 10 preferred alternative is tentatively identified as a hybrid combination of Alternatives 2B(12) and 3B(12) from the Feasibility Study. Key elements of the Preferred Alternative are described below.

- Main Channel Area: The Preferred Alternative relies primarily on dredging in the main channel area. Dredging removes the greatest mass of contaminant, is highly permanent, provides greater certainty in future remedy performance and is compatible with the current and future use of the waterway.
- Sill Reach: For the shallow sill reach at the south end of the site, a 9-inch ENR layer is proposed because overwater structures present significant challenges to dredging and this area is not used for navigation.
- Under-Pier Areas: *In-situ* treatment (most likely with activated carbon) will be used to address under-pier hot spots followed by the application of ENR.

The Preferred Alternative addresses all areas with PCB concentrations greater than 12 mg/kg organic carbon (OC). All alternatives use a combination of active cleanup and natural recovery to achieve risk-based or natural background-based remediation goals as required by state law. Approximately 100 acres of the waterway would be dredged, 7 acres capped, and 13 acres would receive ENR and in-situ treatment. The total dredging volume is estimated at 960,000 cubic yards with a total cost of approximately $290 million.

C. Clearly explain the rationale for the proposed remedy.

The Region believes that a hybrid of Alternatives 2B(12) and 3B(12) best balances contaminant risk reduction, cost, and construction-related short-term risks. There are several key components make the hybrid of these two alternatives the preferred choice.

Main Channel Areas: For the Main Channel areas of the EW, dredging is the preferred remedy as it provides the most reliable and permanent remedy and is consistent with future uses of the waterway. Due to the large size of the deep main channel areas, ENR is predicted to result in a higher SWAC in both the short term and long term than dredging. ENR leaves a greater mass of contaminant available in the waterway to be distributed, resulting in greater uncertainty in future performance. In the Shallow Main Body area, capping (alternative categories “1” and “2”) would require that institutional controls be implemented and maintained, and capping could limit future uses of the waterway (although no impact to immediate future use is expected).

Sill Reach: The Sill Reach poses significant challenges for dredging (“3” alternatives) because of the low bridges present. It is expected that the design criterion for media selected for the proposed 9-inch ENR layer would ensure physical stability in this area and provide sufficient separation from underlying contamination for initial risk reduction while the ENR process is underway. Therefore, ENR (“2” alternatives) is appropriate in the Sill Reach.

Underpier Areas: In situ treatment with a 9” ENR layer is recommended for the underpier areas because it employs an active remedial option to address site contaminants and results in a similar risk reduction as diver-assisted dredging. Given the significantly larger

area, hydraulic dredging in all underpier areas ("E" alternatives) is unnecessarily expensive and risky for workers. In addition, based on the Region's further consideration, the "C+" alternatives do not provide enough advantage in risk reduction and certainty in long-term effectiveness or permanence to outweigh the costs. It appears that the 2-acre hot-spot dredging increases the total remedial cost by about $15 million. However, at 2 acres, the area benefited is very small compared to the full waterway and does not influence the final spatially-weighted average concentration (SWAC). The performance of in situ treatment has been demonstrated in underpier areas; however, there is some uncertainty due to potential for erosion of the treated surface sediment. Diver-assisted dredging will be considered by the Region as a contingency based on post-construction monitoring.

PCB RAL: The remedy selection is the PCB remedial action level (RAL) of 12 mg/kg organic carbon vs. 7.5 mg/kg organic carbon. Decreasing the RAL to 7.5 results in inclusion of an additional 11 acres into the remedy and appears to increase the total remedial cost by about $30 million. Based upon the modeled risk reduction presented in the feasibility study, there is no decrease in short-term (5 year) or long-term (40 year) risk by implementing a RAL of 7.5 vs. 12, despite an overall increase in contaminant mass removal. Based on this and the significant cost difference, a RAL of 12 mg/kg organic carbon is sufficient.

8. ENSURE THAT SEDIMENT CLEANUP LEVELS ARE CLEARLY TIED TO RISK MANAGEMENT GOALS.

The RAOs developed for the EW are based on the results of the baseline human health and ecological risk assessments. The sediment PRGs associated with each RAO are based on the results of the risk assessments or ARARs. The alternatives share the same PRGs and ultimately have the same risk management goals. Long-term sediment and fish tissue concentrations will be measured as part of site-wide monitoring for the action alternatives to assess remedy effectiveness.

A. Briefly summarize the risks associated with contaminated sediments that were identified in the human health and ecological risk assessments.

For human health, the highest contributions to risk were from cPAHs, PCBs, and dioxin/furans based on tribal seafood consumption scenarios. Human health risk was also notable for arsenic and cPAHs via direct contract scenarios (net fishing and clamming).

Ecological risks were most notable for benthic invertebrates based on the evaluation of 29 COCs that were considered risk driver contaminants due to exceedance of the Washington State Sediment Management Standard's Sediment Quality Standards for protection of benthic invertebrates. TBT was also identified as a risk driver for the benthic community along with PCBs for English sole and brown rockfish.

B. What remedial action objectives (RAOs) were developed to address these risks?

The results of the baseline human health and ecological risk assessments indicate that remedial action is warranted to reduce unacceptable human health and ecological risks posed by COCs in the EW. Unacceptable risks were estimated for certain human health exposure scenarios (through seafood consumption and direct contact exposure pathways) and for certain ecological risks (for benthic organisms and for other ecological receptors).

Based on guidance provided under CERCLA and other requirements provided in Washington State MTCA and SMS, four RAOs have been identified for the cleanup of EW sediments. These RAOs, which are preliminary and will be finalized in the ROD, are identified below.

Exhibit 9. RAOs for Sediment

RAO	Description	Point of Compliance
1	Reduce risks associated with the consumption of contaminated resident EW fish and shellfish by adults and children with the highest potential exposure to protect human health.	Surface sediment in the biologically active zone (0 to 10 cm)
2	Reduce risks from direct contact (skin contact and incidental ingestion) to contaminated sediments during netfishing and clamming to protect human health.	For netfishing activities, surface sediments (0 to 10 cm) across the entire site. For clamming, sediment in the upper 25 cm depth interval in designated clamming areas.
3	Reduce to protective levels risks to benthic invertebrates from exposure to contaminated sediments.	Surface sediment (0 to 10 cm)
4	Reduce to protective levels risks to crabs and fish from exposure to contaminated sediment, surface water, and prey.	Surface sediment (0 to 10 cm) site wide average

C. Briefly describe the sediment cleanup and action levels, including how they were derived and how they relate to the RAOs.

Remedial action levels (RALs) and preliminary remediation goals (PRGs) for sediment are provided in Exhibit 8-2. Final action and cleanup levels will be established in the ROD and may differ from the RALs and PRGs presented in Exhibit 10. PRGs are discussed in Section 7 of the NRRB packet and RALs are discussed in Section 8.2 of the NRRB packet.

Exhibit 10. Sediment Cleanup and Action Levels

COC	Remedial Action Levels	Preliminary Remediation Goal (PRG)	PRG Derivation	PRG Relationship to Remedial Action Objectives
Total PCBs (mg/kg OC)	12 (site wide)	2	Background	RAO 1 - Human health fish consumption; RAO 4 – fish and crab
Dioxins/furans (ng TEQ/kg dw)	25 (site wide)	2	Background	RAO 1 - Human health fish consumption
Arsenic (mg/kg dw)	57 (site wide)	7	Background	RAO 2 - Human health direct contact (net fishing)
cPAHs (µg TEQ/kg dw)	4,800 (site wide)	380	Risk Based	RAO 2 - Human health direct contact (net fishing)
	660 (clamming areas)	150	Risk Based	RAO 2- Human health direct contact (clamming)
TBT (mg/kg OC)	7.5 (site wide)	7.5	Risk Based	RAO 3 - Benthic community (bioaccumulation)
29 benthic risk driver COCs	benthic Sediment Cleanup Objective (SCO)	benthic SCO (site wide)	SMS	RAO 3 - Benthic community

The PRGs were based either on risk-based threshold concentrations (RBTCs) or natural background concentrations, whichever value was higher. Laboratory quantitation limits were also considered, but in each case were lower than either the RBTC or background concentration. Risk-based PRGs were based on human health risk using the State of Washington required risk levels. The PRGs based on SMS standards for the protection of the benthic community, were based on the State of Washington SMS standards.

RALs are the point-based concentrations above which sediment is remediated. The process for developing the RALs for EW are discussed in Section 8.2 of the NRRB Packet. Briefly, RALs were developed in a stepwise manner, with each RAL resulting in additional area requiring remediation. The remediation area was first developed based on the protection of benthic invertebrates (RAO 3) because RALs based on RAO 3 risk drivers (including PCBs and arsenic) generate the majority of the remediation area. These RALs were based on SMS benthic numerical criteria (these are the RBTCs for benthic community) and the TBT RBTC. Next, additional remediation areas were added based on RALs for total PCBs and dioxins/furans, because these RALs add the second largest remediation area. Finally, a small remediation area was added based on RALs for cPAHs.

9. MAXIMIZE THE EFFECTIVENESS OF INSTITUTIONAL CONTROLS AND RECOGNIZE THEIR LIMITATIONS.

To be fully protective, the selected remedy will require institutional controls. Seafood consumption advisories are expected to continue indefinitely under all of the alternatives because background levels are predicted to result in risks exceeding thresholds. Seafood tissue contaminant concentrations are predicted to increase in the short term as a result of dredging. Recommended actions for public education, outreach, and notification control elements are the same for the action alternatives. The no action alternative does not include institutional controls for managing residual risks beyond the existing WDOH seafood consumption advisory. Monitoring and notification of waterway users is essential where contamination remains in place following remediation (particularly the containment-focused alternatives, in areas where capping has been utilized). Such controls have been successfully implemented at a wide range of sites regionally and nationally.

A. Briefly list any institutional controls and recognize their limitations.

The preferred alternative requires an Institutional Controls Plan because: a) the alternative is not predicted to achieve PRGs or risk thresholds (even at background concentrations institutional controls would be necessary); and b) subsurface sediment with COC concentrations above levels needed to achieve RAOs would remain in place. Institutional controls in the form of proprietary controls and informational devices such as seafood consumption advisories and educational outreach would all be employed. However, these institutional controls have inherent challenges, and given the uncertainty associated with these controls, monitoring of enforcement will be required. Privately owned sediments, like publically owned sediments, in an urban commercial waterway are more difficult to guard or restrict uses of than upland properties. Further, it is anticipated that some people, will choose to fish and consume what they catch regardless of fishing regulations, seafood consumption advisories, and robust public outreach and education programs.

B. Briefly describe any plans for on-going monitoring and gathering of information at the site which may indicate the effectiveness of institutional controls.

An integrated Institutional Controls Implementation Plan for the EW that meets specific

location, tribal, and community needs is anticipated after the ROD is issued. Enforcement monitoring will be employed as part of the ICIP to ensure institutional controls are implemented. Institutional controls would be required in portions of the open-water capped areas. Both deed restrictions and institutional controls will be considered to manage underpier areas with *in-situ* treatment.

10. DESIGN REMEDIES TO MINIMIZE SHORT-TERM RISKS WHILE ACHIEVING LONG-TERM PROTECTION

The action alternatives include various combinations of remediation technologies. This allows each alternative's performance to be compared with respect to short-term risks and long-term protection. Although all the alternatives achieve similar long-term risk-reduction goals, the time to achieve these goals is different. Conversely, short-term risks to the community and workers and environmental impacts are closely tied to the construction period and remedial technologies used for each alternative. Short-term risks during construction include worker safety, transportation-related impacts on communities, air emissions, habitat disruption, and elevated contaminant concentrations in resident fish and shellfish tissue during and a few years following dredging.

A. Briefly list the cleanup methods or natural processes to be used to achieve long-term protection at the site. The length of time expected to achieve RAOs, and how the short-term risks of implementing those methods are minimized.

Section 9.5.3 of the NRRB packet presents the predicted times at which the alternatives achieve RAOs, as follows:

- RAO 1: All action alternatives are predicted to achieve the same order of magnitude cancer risk and non-cancer HQ; however, model results project that no alternative will meet these PRGs, so institutional controls (e.g., seafood consumption advisories, likely enhanced by public outreach and education programs) will be needed to meet the threshold criterion of protectiveness. Alternative 1A(12) is predicted to achieve the same level of protectiveness but over a longer timeframe than the other action alternatives (34 years from the start of construction, compared to 9 to 13 years). All of the action alternatives are predicted to achieve the other risk metrics at the end of construction (9 to 13 years).
- RAO 2: All action alternatives are predicted to achieve the arsenic PRG at the end of construction. Model predictions indicate that arsenic concentrations in the EW could increase following construction, and maintaining the PRG in the long term is uncertain because of incoming sediment concentrations. All action alternatives are predicted to achieve the cPAH PRG or 1×10^{-6} excess cancer risk immediately after construction completion. The No Action Alternative is predicted to achieve 1×10^{-6} risk for cPAHs for clamming in 20 years.
- RAO 3: Alternative 1A(12) is predicted to achieve the RAO 3 PRGs 39 years from the start of construction, while the other action alternatives are predicted to achieve it immediately after construction completion (9 to 13 years). The No Action Alternative is not expected to achieve the RAO 3 PRGs.

- RAO 4: The No Action Alternative is predicted to achieve RAO 4 PRGs at 10 and 25 years for English sole and brown rockfish, respectively, while all action alternatives are predicted to achieve RAO 4 PRGs after construction completion (9 to 13 years).

Overall, Alternatives 1B(12) and 1C+(12) are predicted to achieve RAOs 2 through 4 in 9 years, followed by Alternatives 2B(12), 2C+(12), 3B(12), and 3C+(12) in 10 years; 2C+(7.5) in 11 years; 3E(7.5) in 13 years; and 1A(12) in 9 years for RAOs 2 and 4 and 39 years for RAO 3. All action alternatives are predicted to meet similar risk thresholds for RAO 1 within 9 to 13 years except Alternative 1A(12), which is predicted to take 34 years to achieve similar child tribal risk thresholds.

Specific measures to reduce short-term risks at the site are summarized in Exhibit 11

Exhibit 11. Long- and Short-term Effectiveness by Remedy Component

Remedy Component	Time Expected to Achieve RAOs	How Short-term Risks are Minimized
Dredging	Immediately post construction	Limited construction periods; BMPs to reduce sediment resuspension and residuals; BMPs to reduce water quality impacts such as initial dewatering on dredge scows; coordination with tribes to ensure impacts to tribal fishing are minimized; BMPs to protect and conserve habitat
Partial removal and capping	Immediately post construction	Limited construction periods; BMPs to reduce sediment resuspension and residuals; BMPs to reduce water quality impacts; coordination with tribes to ensure impacts to tribal fishing are minimized; BMPs to protect and conserve habitat
In situ treatment	Less than 10 years post construction	Limited construction periods; BMPs to reduce water quality impacts; coordination with tribes to ensure impacts to tribal fishing are minimized; BMPs to protect and conserve habitat
ENR	At the completion of construction.	Limited construction periods; BMPs to reduce water quality impacts; coordination with tribes to ensure impacts to tribal fishing are minimized; BMPs to protect and conserve habitat

B. Briefly list the major expected effects of the proposed remedy on societal and cultural practices and how this was considered in remedy selection.

The most notable impact of the remedy will be to fishing practices, both recreational and tribal. During and immediately following construction, fishing will need to be restricted. Long term impacts of the preferred remedy should allow for less restrictions to seafood consumption, though unrestricted seafood consumption is not expected for tribal subsistence fishing given that contaminant background concentrations still pose a risk to tribal consumers.

11. MONITOR DURING AND AFTER SEDIMENT REMEDIATION TO ASSESS AND DOCUMENT REMEDY EFFECTIVENESS.

The action alternatives include extensive short-term and long-term monitoring programs to assess effectiveness, and the cost estimates assume contingency actions based on monitoring results. The No Action Alternative includes long-term site-wide monitoring but does not assume any contingency actions based on the latter monitoring.

A. Briefly describe the type of monitoring that will be required to assess contaminant release during remedy implementation (i.e., during dredging, cap placement, or during the recovery period in the case of monitored natural recovery).

Construction monitoring will be required during implementation and will include water-quality monitoring and monitoring for suspended sediments. The monitoring program will be developed in coordination with each construction plan to ensure that the project is implemented in accordance with plans and specifications (i.e., performance of contractor, equipment, and environmental controls).

B. For each medium that has a cleanup level or remedial action objective listed in the answer to number 8a above, briefly summarize the type of monitoring (including physical, biological, and chemical monitoring) that will be required to determine whether the levels and objectives are met, and determine whether sufficient baseline data are available. Where they are not, briefly indicate plans for additional data collection prior to implementation of the remedy.

Long-term monitoring will evaluate sediment, tissue, and water quality at the site for an extended period following the remedial action to assess risk reduction and progress toward achievement of RAOs. Data collected under long-term monitoring will yield information reflecting the combined actions of sediment remediation and source control.