REMEDIAL DESIGN GUIDELINES AND CONSIDERATIONS

Portland Harbor Superfund Site

Portland, Oregon

U.S. Environmental Protection Agency Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington

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List of Acronyms

AECOM	AECOM Technical Services
ARAR	applicable or relevant and appropriate requirement
BA	biological assessment
BL	baseline sampling
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIG	Climate Impacts Group
CLE	Contingency Level Earthquake
COC	contaminant of concern
CRD	Columbia River Datum
CSM	conceptual site model
CWA	Clean Water Act
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
D/F	dioxins and furans
DLC	dioxin-like congener
DMU	dredge management unit
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESD	explanation of significant differences
FEMA	Federal Emergency Management Agency
FMD	future maintenance dredge
FNC	federal navigation channel
FS	feasibility study
FSP	field sampling plan
Geosyntec	Geosyntec Consultants, Inc.
HEC-RAS	Hydrologic Engineering Center River Analysis System
HPAH	high molecular weight PAH
IC	institutional control
IPCC	Intergovernmental Panel on Climate Change
LPAH	low molecular weight PAH
LWG	Lower Willamette Group
MMP	materials management plan
NAPL	nonaqueous-phase liquid
NMFS	National Marine Fisheries Service
OAR	Oregon Administrative Rule
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl

PDI	pre-design investigation
PeCDD	pentachlorodibenzo-p-dioxin
PP	performing party
PTW	principal threat waste
QAPP	quality assurance project plan
RAL	remedial action level
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
Site	Portland Harbor Superfund Site
SLR	sea level rise
SMA	sediment management area
SOW	statement of work
TCLP	toxic contaminant leaching protocol
TCT	Technical Coordination Team
TEF	toxic equivalency factor
TEQ	toxicity equivalent
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WP	work plan
%	percent
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin

Section 1 Introduction

1.1 Purpose and Scope

This document defines U.S. Environmental Protection Agency (EPA) expectations for remedial design, provides general guidelines to promote remedial design consistency throughout the Portland Harbor Superfund Site (Site), and informs performing parties (PPs) on the overall process for remedial design activities. This document is only a guide; the terminology and information provided supplement the relevant information and general guidance for the design and construction of sediment remedies. It references applicable regulation and guidance but does not include prescriptive, site-specific remedial design approaches or requirements for the remedial action to be implemented in a project area. These site-specific remedial design elements are expected to be developed by PPs for EPA review through the remedial design process.

Based on input from PPs performing remedial design and the Technical Coordination Team (TCT), EPA has developed guidelines on specific design topics that are anticipated to be encountered and addressed during remedial design efforts sitewide. These topics are provided in the appendices, as described in **Section 1.5**.

This document clarifies but does not supersede any requirements presented in the Site Record of Decision (ROD) (EPA 2017b) or the Explanation of Significant Differences (ESD) (EPA 2019b).

1.2 Remedial Design Requirements

This document expands on the remedial design requirements presented in the ROD and provides guidelines for technology assignment selection. The lateral extent of technology assignments identified for the selected remedy (ROD Figures 31a through 31e) was determined using data obtained during the remedial investigation (RI) and feasibility study (FS). As described in **Section 5** of this document, the technology assignments and remedial footprint will be finalized during remedial design following data collection.

1.3 Remedial Design Agreements or Orders

Prior to the start of remedial design, PPs will enter into an administrative settlement agreement and order on consent or other legal mechanism with EPA that identifies the activities to be performed during remedial design. A statement of work (SOW) that sets forth the procedures and requirements for completing the remedial design will be attached to each agreement. Each SOW will typically include requirements pertaining to community involvement, remedial design objectives, pre-design investigations (PDIs), treatability studies, remedial design submittals, emergency response, reporting, and the schedule.

1.4 Remedial Design Principles

The following remedial design principles were developed to ensure all parties working on remedial designs at the Site have a common understanding of these topics. These principles are meant to supplement, not supersede or revise, the ROD and ESD.

1. *Sediment Management Areas*: According to Section 10.1 of the ROD, "sediment management areas (SMAs) were identified as areas where containment or removal technologies were considered to immediately reduce risks upon implementation." An SMA is where active remediation, rather than natural recovery, will be performed as selected in the ROD. As further described in the ROD, an SMA will be delineated by surface and subsurface contamination above remedial action levels (RALs) and principal threat waste (PTW) thresholds. Whether subsurface RAL and PTW threshold exceedances are included as part of the SMA depends on the depth of RAL/PTW threshold exceedances and whether buried RAL/PTW threshold exceedances are anticipated, based on site conditions, to be exposed in the future (see #2 below for additional details). Areas with RAL/PTW threshold exceedances at the surface must be actively remediated (i.e., by dredging/capping or both) per Section 14 of the ROD. However, a RAL exceedance in a single sample (surface or subsurface) that is not representative of the surrounding sediment does not necessarily compel action per Section 14. SMAs identified in the ROD will be further refined during the remedial design process through sampling and a better understanding of reasonably anticipated future site uses. ROD technologies will then be determined through application of the decision tree.

2. *Buried Contamination*: In some areas, sediment contaminants of concern (COCs) that exceed the RALs or PTW thresholds may be buried beneath surficial sediments[1] that are below RALs and PTW thresholds[2]. Whether or not these areas will be included in an SMA depends on the chemical and physical stability of the buried material and reasonably anticipated future site uses. Site-specific information will be developed by PPs to assess whether sediments with COC concentrations exceeding RALs or PTW thresholds are likely to be exposed or if concentrations exceeding cleanup levels can be expected at the sediment surface. Fate and transport modeling will be required to support these evaluations, the details of which will be included in **Appendix B** as additional guidelines are developed. The assessments will address the chemical and physical stability of the buried contamination based on factors such as erosion/scour potential, chemical concentrations compared to RAL and PTW thresholds, depth of contamination, and advective transport. The remedial action applied to these areas may include active remediation and will involve planning and implementing a long-term monitoring program to confirm site-specific determinations for physical stability and chemical isolation.

3. *Data Replacement*: PPs in remedial design may develop their own site-specific data replacement strategy, as approved by EPA. The strategy must meet reasonable standards and considerations such as the presence of outliers, heterogeneity of the substrate, natural recovery occurrence, deposition, erosion/scour potential, sampling

[1] Surficial sediments are defined based on the ROD-identified 0- to 30-centimeter depth. Sediments below 30 centimeters are considered subsurface sediments, consistent with the ROD.
[2] Section 14.2.4 of the ROD states the following for shallow areas: "Where PTW is not present but the depth of excavation to achieve RAL concentrations is greater than 5 feet, the area will be dredged to 5 feet with placement of a cap and backfilled to grade (capped per design requirements in Section 14.2.9, Design Requirements)."

density/resolution, and age of the data. Further guidance on data replacement is provided in **Appendix B**.

Replacement will be determined on a project area- and sample location-specific basis using trends over time. Subsurface sediment data cannot be replaced. Surface data replacements need to consider differences in the sample dates and locations between sample pairs. Data collected in 2018 to 2019 and as part of remedial design can be used to adjust the SMAs. Further guidance on these issues is provided in **Sections 4.2** and **5**.

4. *Technology Assignment*: The ROD decision tree is the foundation by which technology assignments are applied and site-specific design requirements are to be made consistent with Section 14.2.9 of the ROD. PPs need to develop the necessary site-specific information and considerations to be incorporated under the remedial design process for final remedial technology assignments.

   The ROD decision tree contains flexibility in the application of remedial technologies, for example, by specifying "dredge and/or cap" in some areas of the intermediate zone. In such areas of flexibility, technologies should be selected based on an analysis of the chemical, physical, and anthropogenic features, and compatibility with dredging and/or capping. In areas where the decision tree specifies a technology, EPA retains the flexibility to modify that outcome if there are site-specific data and analyses that preclude the feasible implementation of the approach identified in the ROD. For example, capping is specified under functional structures, but the construction of a cap may not be feasible in some cases (e.g., on over-steepened slopes where cap materials would not be stable) and alternative approaches can be evaluated in consultation with EPA.

5. *Equivalence Analysis*: Equivalency is a robust statistical method that provides a high level of certainty when determining whether concentrations between two areas of interest are or are not statistically equivalent. It is a statistical method widely used across several industries and in various regulatory applications nationwide, including mine reclamation, pesticide registration, and generic drug testing. At the Site, the equivalence analysis may be used and developed in coordination with PPs, the Oregon Department of Environmental Quality (DEQ), and EPA's trustee partners to assess progress toward cleanup. Prior to achieving ROD or ESD cleanup levels, and to support five-year reviews, equivalence analysis can be used to evaluate whether the remedy is functioning as intended. In this regard, contaminant concentrations at the Site can be compared to the Upriver Reach, Downtown Reach, or both reaches, to evaluate whether they are equivalent with those areas.

   Background-based cleanup levels were derived from sediment collected in the upstream reach. Ongoing source control, remediation, and natural processes in the upstream reach suggest that COC levels in that reach may change over time. Cleanup levels are not expected to be met until after active remediation. In the post-remediation timeframe, the upstream background concentrations will be reviewed and background-based cleanup levels will be updated based on recent data, as needed, as part of the five-year review process. Equivalency approaches will be used in evaluating the attainment of the cleanup levels and remedial action objectives (RAOs).

6. *Isolated 1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD) and 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Contamination That Exceeds RALs But Is Below PTW Thresholds*: The RI/FS sampling did not include extensive data for PeCDD and TCDD. RI/FS surface sediment samples analyzed for PeCDD and TCDD were targeted in areas of the Site with less spatial coverage than other COCs. Sampling conducted in 2018 and 2019 indicates that PeCDD and TCDD are colocated with other focused COCs; however, there may be areas of isolated PeCDD and TCDD contamination that exceed RALs but are below PTW thresholds. Isolated PeCDD and/or TCDD contamination areas with sediment concentrations exceeding RALs but below PTW thresholds (i.e., areas where surface sediment is contaminated with PeCDD and/or TCDD but there are no underlying subsurface RAL/PTW exceedances of other COCs) that are generally nonerosive may use thin caps or thin reactive caps, as needed, to reliably contain PeCDD and/or TCDD. The current understanding of the extent of isolated PeCDD and TCDD RAL exceedances in surface sediment indicates that these areas are spread over approximately 6 acres of the Site. These areas may be refined based on surface and subsurface design data as it becomes available. The thin caps or thin reactive caps will need to be evaluated based on all ROD requirements for caps, such as cap design modeling, erosion evaluations, climate change resiliency, seismic impacts, etc. Details on how to address isolated PeCDD and TCDD contamination will be included in **Appendix B** as additional guidelines are developed.

1.5 Document Organization

This document is organized as follows:

- Section 1: Introduction – Describes the document purpose and introductory information.
- Section 2: Remedial Action Objectives and Criteria – Describes RAOs, cleanup levels, RALs, PTW thresholds, and analytical data summation rules.
- Section 3: Technology Assignment Selection and Flexibility – Describes how the selected remedy will be applied for each area of the Site and the flexibility of the technology application decision tree.
- Section 4: Existing Data Review – Outlines how the remedial design process should review existing information relevant to the design and identify data gaps.
- Section 5: Remedial Design Activities, Evaluations, and Considerations – Identifies work to be performed as part of the remedial design process.
- Section 6: Planning and Design Submittals – Describes the documents to be prepared and submitted to EPA during remedial design.
- Section 7: References – Lists the documents referred to in this guide.

Appendices for this document include:

- Appendix A: Remedial Design Frequently Asked Questions – Provides responses to frequently asked questions pertaining to remedial design and remedial technologies.
- Appendix B: Remedial Design Topics and Discussion – Provides detailed information on specific design topics that are not fully addressed in this remedial design guidelines document. This appendix is a living document and will be updated as new topics are identified and worked through with PPs. An updated version of this appendix will be issued periodically with a new version number and date.
- Appendix C: Monitoring and Points of Compliance – Describes the points of compliance that will guide remedy design and construction for each technology type and the monitoring necessary to evaluate remedy performance for each technology applied in the selected remedy.
- Appendix D: Guidance for Riverbank Characterizations and Evaluations – Describes the process for characterizing riverbanks for informing remedial design within the Site and the methods for evaluating their erodibility.
- Appendix E: Example Sufficiency Assessment Table – Provides an example sufficiency assessment summary table that identifies the status of potential sources at the project area and documents whether these sources will be sufficiently addressed for the cleanup to proceed.
- Appendix F: Remedial Design Frequent Comments – Provides a summary of EPA comments that are frequently provided to the PPs during remedial design document reviews for the Site.

Section 2 Remedial Action Objectives and Criteria

2.1 Remedial Action Objectives

The nine RAOs included in the ROD consist of media-specific goals for protecting human health and the environment. Achieving the RAOs relies on effectively implementing the selected remedy to meet the cleanup levels discussed in **Section 2.2**. The nine RAOs are provided below.

Human Health RAOs

- RAO 1 – Sediment: Reduce cancer and noncancer risks to people from incidental ingestion of and dermal contact with COCs in sediment and beaches to exposure levels that are acceptable for fishing, occupational, recreational, and ceremonial uses.
- RAO 2 – Biota: Reduce cancer and noncancer risks to acceptable exposure levels (direct and indirect) for human consumption of COCs in fish and shellfish.
- RAO 3 – Surface Water: Reduce cancer and noncancer risks to people from direct contact (ingestion, inhalation, and dermal contact) with COCs in surface water to exposure levels that are acceptable for fishing, occupational, recreational, and potential drinking water supply.
- RAO 4 – Groundwater: Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure.

Ecological RAOs

- RAO 5 – Sediment: Reduce risk to benthic organisms from ingestion of and direct contact with COCs in sediment to acceptable exposure levels.
- RAO 6 – Biota (Predators): Reduce risks to ecological receptors that consume COCs in prey to acceptable exposure levels.
- RAO 7 – Surface Water: Reduce risks to ecological receptors from ingestion of and direct contact with COCs in surface water to acceptable exposure levels.
- RAO 8 – Groundwater: Reduce migration of COCs in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for ecological exposure.

Human Health and Ecological RAO

- RAO 9 – Riverbanks: Reduce migration of COCs in riverbanks to sediment and surface water such that levels are acceptable in sediment and surface water for human health and ecological exposures. For additional information on riverbanks refer to **Appendix D**.

PPs shall develop remedial designs for contaminated sediments and demonstrate that they will be protective of human health and the environment relative to RAOs 1 through 8. RAO 9 will be achieved through riverbank cleanups implemented under the ROD/ESD with oversight by EPA and in conjunction with upland source control actions implemented with oversight by DEQ.

2.2 Cleanup Levels

Cleanup levels are the long-term contaminant concentrations that need to be achieved by the selected remedy to meet RAOs. Site-specific cleanup levels were developed for each RAO for the following media: sediment (including beaches) and riverbank soil, surface water, and groundwater. In addition, target tissue levels were established for fish tissue. The media-specific cleanup levels and target tissue levels are provided in Table 17 of ROD Appendix I and ESD Appendix A1.

2.3 Remedial Action Levels and Principal Threat Waste Thresholds

SMAs identified in the ROD were delineated based on the RALs and/or PTW thresholds (whichever is the lower value) for the selected remedy and represent areas of sediment contamination where capping and/or dredging will be performed to reduce site risk. Sitewide RALs, navigation channel RALs, and PTW thresholds are listed in Table 21 in ROD Appendix II and ESD Appendix A1. Navigation channel RALs only apply to the navigation channel, and Sitewide RALs apply to all other areas of the Site. Within the navigation channel, some PTW thresholds are lower than the navigation channel RAL and thus will be applicable.

2.4 Analytical Data Summation Rules

Some COC concentrations are calculated as sums of related chemicals (e.g., chlorinated dioxins and furans [D/F], polychlorinated biphenyls [PCBs], selected groups of chlorinated pesticides, and polycyclic aromatic hydrocarbons [PAHs]) rather than individually. This approach requires that concentrations for individual analytes within a group be summed to obtain a single result. Data summation rules were developed during implementation of the RI and FS, and the remedial design will use the risk assessment and FS summation rules. For detailed summation rules, refer to the Program Data Management Plan (EPA 2020).

Section 3 Technology Assignment Selection and Flexibility

3.1 Remedial Technologies

The selected remedy relies on capping and dredging of areas with highly contaminated sediment, and enhanced natural recovery and monitored natural recovery in areas with low levels of contamination. The selected remedy also relies on institutional controls (ICs) to manage remaining risks associated with fish consumption and to protect the remedy.

The selected remedy includes an approximate total constructed area of 394 acres of contaminated sediment and 23,305 lineal feet of riverbank and will allow approximately 1,774 acres of sediment to naturally recover. Approximately 3,017,000 cubic yards of contaminated sediment and 123,000 cubic yards of contaminated material from riverbanks will be removed and sent to off-site disposal facilities. Material testing will be performed to determine whether removed material will be sent to a Resource Conservation and Recovery Act (RCRA) Subtitle C or D disposal facility. The need for and extent of ex situ treatment will be based on the off-site disposal requirements and material testing during design and construction.

Areas to be capped or dredged will be defined by RALs and PTW thresholds, which are concentrations of focused COCs and additional contaminants used to define areas for more active cleanup for the selected remedy. The selected remedy relies on two sets of RALs: Sitewide RALs, which apply to all areas of the Site except the navigation channel, and navigation channel RALs. RALs and PTW thresholds are listed in Table 21 in ROD Appendix II and ESD Appendix A1.

The selected remedy will be applied on an area-specific basis as described in ROD Section 14.2 and is summarized for each area below.

- Navigation Channel: The navigation channel refers to the federally authorized navigation channel and the selected remedy here includes dredging of contaminated sediment above the navigation channel RALs or PTW thresholds, whichever is lower. Where RALs or PTW thresholds are achieved through dredging, placement of a residual layer will occur as soon as is practicable following dredging within the prism and surrounding area that may have been impacted by dredge residuals. If RALs are not achieved or PTW is present below the feasible depth limit of the excavation technology, a cap shall be placed after dredging, provided the final constructed elevation is below the authorized depth of the navigation channel, including an overdredge allowance/buffer zone. If nonaqueous-phase liquid (NAPL) or not reliably contained PTW exists below the feasible depth of excavation, a significantly augmented cap shall be required.

- Future Maintenance Dredge Areas: Future maintenance dredge (FMD) areas are those locations in the river that are periodically dredged to allow continued marine activity, such as vessel activity, shipping, docking, etc. The selected remedy in FMD areas includes dredging of contaminated sediment above the Sitewide RALs to a depth required to allow placement of a cap or backfill material sufficient to be effective over the long term. Where

RALs are achieved through dredging, placement of a residual layer will occur as soon as is practicable following dredging within the prism and surrounding area that may have been impacted by dredge residuals. NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology, in which case a significantly augmented cap will be required. A reactive residual layer (sand plus activated carbon) is assumed after dredging if PTW that can be contained lies below the feasible limits of excavation, as described in Section 14.2.9 of the ROD. Maintenance dredge depth requirements will need to be considered during design and implementation of the selected remedy such that the final constructed elevation is below the maintained depth, including an overdredge allowance or buffer zone.

- Intermediate Region: The intermediate region is defined as outside the horizontal limits of the navigation channel and FMD areas to the riverbed elevation of approximately -2 feet Columbia River Datum (CRD). The selected remedy in the intermediate region includes dredging of contaminated sediment to the depth required to remove PTW and sediments with contaminant concentrations exceeding Sitewide RALs, or to a depth required to allow placement of cap or backfill material sufficient to be effective over the long term. During design and construction, the final elevation of capped and dredged areas will be considered such that the leave surface of the constructed remedy is appropriate for the post-construction use of each specific area. NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology, in which case a significantly augmented cap will be required. The ROD states that the elevation of the top of the cap or residual layer (i.e., top of the habitat layer) will be no higher than the pre-design elevation to avoid loss of submerged aquatic habitat, preserve slope stability, and negate adverse impacts to the floodway. However, EPA recognizes that, in some cases, based on robust remedial design evaluations of flood rise and habitat considerations, the placement of a cap without dredging may be allowed and desirable to minimize disruption or improve habitat while maintaining remedy effectiveness. If remedial design evaluations determine that there are no adverse impacts to habitat and the floodway due to capping in the intermediate region, or if encroachments due to capping can be mitigated, then the elevation of the top of a cap may not need to be the same as the pre-design elevation. If appropriate to protect sensitive species, a habitat layer will be incorporated into the constructed remedy.

- Shallow Region: The shallow region is defined as shoreward of the riverbed elevation of approximately -2 feet CRD. The selected remedy in the shallow region includes dredging of contaminated sediment to the depth required to remove all NAPL or PTW that cannot be reliably contained unless it is below the feasible depth limit of excavation, in which case a significantly augmented cap will be required. Where PTW is not present but the depth of excavation to achieve RALs is greater than 5 feet, the area will be dredged to 5 feet, capped, and backfilled to grade. The ROD states that the elevation of the top of the cap or residual layer (i.e., top of the habitat layer) will be no higher than the pre-design elevation to avoid loss of submerged aquatic habitat, preserve slope stability, and negate adverse impacts to the floodway. As stated above, if remedial design evaluations determine that there are no adverse impacts to habitat and the floodway because of capping in the shallow region, or if encroachments because of capping can be mitigated, then the elevation of the top of a cap may not need to be the same as the pre-design elevation. In the shallow regions, a habitat layer, such as beach mix, will be used for the final layer of clean cover in residual management areas and capped areas to maintain the natural habitat.

- Riverbank Region: Remediation of contaminated riverbanks is included in the selected remedy where it is determined that it should be conducted in conjunction with the in-river actions and to protect the remedy (ROD Section 6.6.6, and Figures 9 and 30). Other riverbanks may be included in the remedial action if contamination contiguous with contaminated river sediment is found during remedial design sampling. Details for remedial design evaluations within the riverbank region can be found in **Appendix D**.

3.2 Technology Performance Standards

As described in Section 14.2.10 of the ROD, performance standards related to implementation of the selected remedy will be fully developed during the remedial design and based on environmental media (e.g., sediment, groundwater, surface water) and scientific criteria. The performance standards will serve as the basis for the design objectives of the selected remedy and will be incorporated into all relevant remedial design documents. Remedial design objectives will be developed to meet all RAOs.

Compensatory mitigation projects, should they be needed, will include performance standards such as native plant coverage, invasive species limits, and target species presence (versus absence). A summary of remedial technology-specific performance standards is presented in **Table 3-1**.

3.3 Technology Assignment Application Flexibility

Figure 28 of the ROD outlines the technology assignment process based on consideration of river region area, presence of structures, presence of PTW, and depth of contamination. Section 14.2.9 of the ROD provides additional details on design requirements. The purpose of the technology assignment process is to provide flexibility in the design and construction of the selected remedy based on site-specific information. It is expected that pre-design characterization activities will gather the information necessary to implement the Technology Application Decision Tree. In addition, other information may be collected to support various elements of the remedial design such as incorporation of habitat considerations, flood rise and flood storage, and off-site disposal.

A summary of how this information may be used to refine the selected remedy based on site-specific information is presented below; more information is provided in **Appendix A**.

- Structures: The presence of site structures, such as dolphins, docks, and bulkheads, will influence application of the Technology Application Decision Tree and the design and construction of the remedy. The selected remedy allows for cap placement in areas that would otherwise require dredging or excavation if the structure is functional and immoveable. Functional structures are defined as those structures that are currently in operation or are being used to stabilize the riverbank and expected to have a service life greater than 50 years. This would include capping below functional dock structures and adjacent to functional bulkheads and other structures. Nonfunctional or movable structures are expected to be removed or moved to allow access to contaminated material and implementation of the Technology Application Decision Tree as if no structure was present. It is expected that pre-remedial design activities will include site surveys to determine the functionality and stability of site structures to determine which may be removed prior to construction of the selected remedy and to understand the effect of the selected remedy on the stability of structures that are expected to remain. Consistent with the Technology Application Decision Tree, nonfunctional structures will be removed.

- Waterway Use: Sediment caps placed within the navigation channel and FMD areas will be designed to avoid adverse impacts to current and future navigation based on expected cap thickness, authorized channel depth, and appropriate buffer. Because the location and authorized channel depth of the navigation channel and FMD areas may change in the future, pre-remedial design activities should include a survey of current and anticipated waterway use in the vicinity of the remedial footprint. This survey should consider potential changes in navigation requirements for the purpose of implementing the Technology Assignment Decision Tree. Information regarding current and anticipated waterway use will be used to determine whether the remedial footprint falls within the navigation channel and FMD areas and the current and future navigation depth requirements in these areas. Changes in waterway use determine the remedial technology to be assigned and influence the design of any caps to be placed within these areas.

- Habitat Considerations: The selected remedy includes provisions for the incorporation of habitat layers into the constructed remedy within the shallow and intermediate regions. In addition, the general capping requirements require the use of suitable habitat materials and minimizing adverse effects on in-river and riparian habitat, including the loss of shallow water habitat. Pre-remedial design activities should include a habitat survey in the vicinity of the remedial footprint to determine the current and future habitat requirements for the purpose of designing and constructing the selected remedy. Additional requirements may be determined during remedial design in coordination with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). Coordination with tribal stakeholders will also take place through the TCT review process.

- Flood Rise and Flood Storage: The selected remedy requires that sediment caps be designed to avoid adverse impacts to the floodway, consistent with the Executive Orders for Floodplain Management (11988 and 13690) and Federal Emergency Management Agency (FEMA) regulations. This may limit cap construction in some locations or require removal of contaminated sediment prior to cap placement. Pre-remedial design activities should include the collection of the necessary bathymetric and hydrodynamic data to design and construct sediment caps to prevent unacceptable flood rise. Flood rise analysis will be performed on a Sitewide and project-area basis.

- PTW: The selected remedy includes provisions for the removal, in situ treatment, and capping of PTW. For any NAPL or PTW that is not reliably containable, cap designs will include organoclay, other reactive material, and/or low permeability material, as necessary, to provide a sufficient chemical isolation layer to reliably contain underlying contamination. In addition, capping of highly toxic PTW may require the use of activated carbon and/or other reactive material, as necessary, to meet RAOs. Pre-remedial design activities will include collection of the necessary physical and chemical data to design and construct caps that reliably contain the underlying PTW material.

- Depth of Feasible Excavation: The selected remedy includes removal of all sediment contamination exceeding the RALs and PTW thresholds within the navigation channel and FMD areas unless the contamination is below the feasible depth limit of excavation. The selected remedy also includes the removal all NAPL or PTW that cannot be reliably contained within the intermediate and shallow regions unless it is present below the feasible depth limit of excavation technology. Pre-remedial design activities should include collection of the necessary chemical and physical data necessary to determine the feasible depth limit.

- Disposal: The selected remedy includes the disposal of contaminated material in an off-site Subtitle C or Subtitle D landfill. Pre-remedial design activities should include characterization of all material to be dredged or excavated to determine whether treatment is necessary prior to disposal and to determine appropriate disposal locations.

Section 4 Existing Data Review

4.1 SMA Conceptual Site Model Update

The first step in the remedial design process should be a review of existing information relevant to the design and construction of the selected remedy on an SMA-specific basis. This information must be summarized in a PDI work plan (WP) and used to develop and/or update an SMA-specific conceptual site model (CSM). The CSM and remedial design objectives will serve as the basis for the remedial design and be used to determine data needs for the design and construction of the selected remedy on an SMA-specific basis.

The CSM defines the relationship of site COCs with known or suspected sources of contamination, release and transport mechanisms, affected media, existing and potential exposure pathways, and known or potential human and ecological receptors that may be at risk. The updated CSM will identify all sources of contamination to be addressed by the selected remedy, including contaminants, contaminant sources, contaminant migration pathways, affected media, and applicable RAOs. The updated CSM, developed on an SMA-specific basis, will rely on EPA-approved data collected during the RI/FS, and the 2018 to 2019 PDI and baseline sampling (BL) data (AECOM Technical Services [AECOM] and Geosyntec Consultants, Inc. [Geosyntec] 2019; EPA 2019a), and will serve as a mechanism for identifying data gaps to be filled during PDIs.

Key elements of the CSM include:

- Site description, including site history, land and waterway use, infrastructure, and access
- Preliminary remedial design objectives
- Physical characteristics, including water depth, hydrodynamic regime, hydrogeological characteristics (i.e., rate of groundwater flux), geotechnical characteristics, shoreline stability, the presence of debris, and ecological and habitat characteristics
- Contaminant characteristics, including the nature and extent of contamination for COCs for all relevant media, sources of contamination, and migration pathways

Following the collection of additional data and site information, the CSM should be updated prior to the development of the remedial design documents described in **Section 6**.

4.2 Data Gap Analysis

The data gaps analysis shall be based on collection of the necessary information to implement the Technology Application Decision Tree and design and construct the selected remedy on an SMA basis. Data gaps may be related to nature and extent of contamination, current and anticipated land and waterway use, site infrastructure, and the physical characteristics of the SMA and surrounding area.

Updated surface sediment chemistry data will be required to delineate the remedial footprint and to implement the Technology Application Decision Tree. Because of the limited subsurface chemistry data collected during the RI/FS, it is expected that subsurface sediment data will be required to delineate the remedial footprint and establish the vertical extent of contamination. Additional updated site information required to implement the Technology Application Decision Tree includes SMA-specific information on land and waterway use, site structures, water depth, and preliminary information regarding the horizontal and vertical extent of contamination.

Additional data will be needed to design and construct the selected remedy. This more detailed information includes horizontal and vertical extent of contamination, waste characterization, hydrodynamics (including currents, wind- and vessel-generated waves, and propwash potential), access and infrastructure, geotechnical and physical conditions, debris, groundwater flux, and other information. A detailed discussion of remedial design data needs is presented in **Section 5**.

Section 5 Remedial Design Activities, Evaluations, and Considerations

Remedial design activities and evaluations to be performed by the PP, and considerations to design and construct EPA's selected remedy are described in this section. The primary purpose of these activities is to collect information needed to fill data gaps, refine SMA boundaries, and justify proposed remedial technologies. The work outlined below is required for a typical site, but the activities and evaluations may vary depending on site-specific conditions. Additional information regarding specific design issues that are not fully addressed in this remedial design guidelines document are provided in **Appendix B**. Additional information regarding the points of compliance to be used for remedial design is provided in **Appendix C**.

Phasing of data collection may be proposed by the PP and details of the phasing must be presented in plans for EPA and TCT review. For example, an initial sampling round can be completed for SMA delineation and technology assignment selection, followed by additional sampling for dredge prism design, refinement of PTW extent, waste characterization, and collection of remaining geotechnical data that are needed. The process of collecting remedial design data and sampling methods shall be presented in a PDI WP.

5.1 Remedial Design Activities

5.1.1 Site Surveys

Surveys to be conducted include habitat, topographic, bathymetric, hydrodynamic, debris, utility, land and waterway use, infrastructure, and cultural resource surveys. Surveys may include the collection of physical data (e.g., topography, bathymetry, debris, habitat, waterway currents) and a review of existing information regarding use, infrastructure, and features. The PP should evaluate all existing survey data and identify data requirements to design and implement the selected remedy. The PP is responsible for conducting additional surveys to fill any data gaps or to obtain up-to-date survey information, which shall be presented in the form of maps, drawings, and data reports. Any additional surveys conducted shall be consistent with surveys presented in the ROD and should aim to inform the remedial design evaluations.

If a remedial design includes the removal or modification of a structure (e.g., building, dock, pier) that potentially has historic significance, the PP shall submit documentation to the Oregon State Historic Preservation Office for review. Structures requiring review are at least 50 years old and have not had major alterations to key features. Additional information regarding Section 106 documentation is available at the Oregon State Historic Preservation Office website. Submission should be made as early as possible to avoid project delays.

5.1.2 Sediment Sampling and Analyses for SMA Delineation

The SMA boundary for the selected remedy, as shown on ROD Figure 30 and updated on ESD Figure 8, was estimated using RI surface sediment data. Additional data are needed to supplement RI/FS and PDI/BL data to further refine and delineate the current lateral and vertical extent of cap and/or dredge areas to accurately delineate SMA boundaries. As discussed in

Section 1.4, an SMA will be delineated by surface and subsurface contamination above RALs and PTW thresholds. Validated sediment grab data collected under EPA-approved surface sediment sampling plans will be treated as surface sediment. This will result in data consistent with the ROD-defined 0- to 30-centimeter depth for surface sediment. Sediments below 30 centimeters are considered subsurface sediments, consistent with the ROD.

Data shall be collected to delineate lateral and vertical extent of sediment exceeding the Sitewide RALs, navigation channel RALs, and/or PTW thresholds, as listed in ROD Table 21 and ESD Appendix A1. Contaminated sediment shall be delineated to the depth of the applicable RAL or PTW thresholds, whichever value is lower. Sediment cores shall be advanced within the SMA footprints and spaced on a nominal 150- by 150-foot grid. Additionally, a 150-foot buffer zone of sediment core "step out" locations shall be advanced to delineate the extent of COCs above the applicable RALs and PTW thresholds. If COCs are above the applicable RALs and PTW thresholds at a step out location, an additional core will be advanced no farther than 150 feet from the core location(s) with COCs above the RALs and PTW thresholds. This process will continue until the lateral extent of sediment above the applicable RALs and PTW thresholds is delineated and the vertical extent of COCs above the applicable RALs and PTW thresholds is delineated to the depth of feasible dredge limits or to characterize material to be capped consistent with the selected remedy.

As discussed in **Section 1.4**, delineating the vertical extent of COCs shall require characterization of subsurface sediment contamination to the depth of contamination. The final core depth and sampling intervals will be determined based on the expected depth of contamination using existing data, the CSM (e.g., contaminant release mechanism and hydrodynamic setting), and the anticipated technology to be applied. Sediment shall be collected with a Vibracore or similar method that allows penetration to the required depth, collects sediment samples at sampling intervals of at least 30 centimeters (1 foot), recovers 80 percent (%) of the sampling interval, and establishes the vertical extent of contamination. The vertical extent of contamination will be considered delineated when two consecutive 30-centimeter sampling intervals are below the applicable RAL or PTW threshold. Specific details regarding the sampling program (e.g., sample location, depth, step out core installation procedures, archiving procedures) shall be presented in project plans and subject to EPA approval.

Sediment samples will be analyzed for focused COCs and additional contaminants listed in ROD Table 21 and updated in ESD Appendix A1. Additional analyses, as needed, may include NAPL identification, total organic carbon, grain size, and additional geotechnical parameters, as needed. It is anticipated that additional sediment sample locations will be needed for developing the dredge prism and/or designing the sediment cap.

5.1.3 PTW Identification and Assessment

As stated in ROD Sections 6.5.1 and 13, PTW is to be identified based on a 10^{-3} cancer risk (highly toxic concentrations), presence of NAPL or not reliably containable material (source material), or an evaluation of mobility of contaminants in the sediments. ROD Figure 8 identifies general locations where NAPL and not reliably containable material were identified. The PP shall conduct sampling to delineate exact locations of source material within their project area. Assessments to identify COCs exceeding the highly toxic PTW thresholds shall be conducted, and cap modeling will be used to design and construct a cap that can reliably contain underlying contamination and prevent contaminant migration through the cap. All PTW locations will be identified on a site-specific basis as defined in ROD Section 13. Not reliably containable PTW thresholds are provided in ROD Table 21 (EPA 2017b). Highly toxic and not reliably containable PTW have numerical thresholds but NAPL will be identified based on visual observations and other methods (e.g., ultraviolet photography).

5.1.4 Porewater Sampling and Analyses

In addition to groundwater, ROD RAOs 4 and 8 also apply to contaminant concentrations in porewater. Recent EPA guidance states that the freely dissolved concentration in porewater is proportional to toxicity (EPA 2017a) and should be collected and analyzed at sediment sites in conjunction with bulk sediment measurements. Transition zone water/porewater data may not have been collected during the RI or may not be representative of the current site environment. As a result, additional sampling is necessary to clearly define freely dissolved contaminant concentrations, specifically in capping areas or where residual groundwater plumes may discharge to the river.

Porewater concentrations should be measured using methods described in EPA guidance documents (EPA 2005, 2017a) and are a key input for cap design evaluations. Data collection methods to be used for porewater sampling (e.g., passive samplers) shall be described in the field sampling plan (FSP)/quality assurance project plan (QAPP). Colocated sediment cores should be collected at porewater sampling locations.

Porewater sampling and seepage rate measurements should be conducted at a time of the year when groundwater flux into the river is at its maximum to reduce surface water influx interference and uncertainty of the sample being representative of porewater conditions. This optimal porewater sampling and seepage measurement period should be determined by evaluating historical river stage and groundwater data as localized to the Site as possible. Based on review of surface water and groundwater data, investigation timing should be planned during times of the year when the river is dropping, has less tidal fluctuations, and seasonal groundwater levels are elevated.

5.1.5 Groundwater Seepage Measurements

Upward hydraulic gradients at the groundwater-surface water interface drive contaminant flux through sediments and caps. Accurate, site-specific groundwater seepage rates over the area of interest are required to determine contaminant transport through caps because of advection, which can be the primary mechanism of transport in high-seepage areas. Piezometers and/or seepage meters should be used to quantify seepage rates and specific sampling details should be provided in the FSP/QAPP. Groundwater seepage measurements should be colocated with porewater sampling locations as much as possible and conducted during the same time period as discussed in **Section 5.1.4**.

5.1.6 Preliminary Waste Characterization

Preliminary waste characterization should be performed to identify and select appropriate disposal sites for dewatered sediment during remedial design. Bulk sediment cores shall be collected for waste characterization as part of the sediment sampling program. The analytical results will inform whether the dredged sediment is hazardous or nonhazardous for disposal purposes. Treatment prior to disposal and landfill permit requirements shall be evaluated for acceptance at different permitted disposal facilities (i.e., Subtitle C, Subtitle D). **Section 5.3.6.2** provides additional details regarding waste disposal.

5.1.7 Cap/Clean Borrow Material Testing

The PP shall assess potential borrow sites to supply clean material to be used in engineered caps and sand covers. In addition to compliance with ROD/ESD cleanup levels, the PP shall identify physical and geochemical characteristics of potential borrow material to demonstrate during remedial design that the borrow material meets stability requirements and has the required characteristics to support benthic communities. Representative samples shall be collected from potential borrow sites and analyzed to determine suitability for use during remedial design. EPA recommends samples be collected at a frequency of one sample per 500 cubic yards of borrow material. Sample numbers per volume of borrow material may be adjusted on a site-specific basis after consultation with EPA.

5.1.8 Dredge Elutriate Testing

Samples for dredge elutriate testing shall be collected to evaluate the potential for short-term contaminant releases during dredging operations. Sample locations, methods, and analysis details shall be provided in the FSP/QAPP. The results from dredge elutriate testing shall be evaluated against water quality criteria and used to support EPA's development of performance standards for use during dredging operations. Elutriate testing procedures are described in *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual* (U.S. Army Corps of Engineers [USACE] 2003).

5.1.9 Treatability Studies

The ROD specifies that reactive amendments, such as activated carbon or organoclay, will be used in the three types of caps—reactive caps, armored reactive caps, and significantly augmented reactive caps. Bench- or pilot-scale treatability studies (e.g., sorption isotherm and column studies) to evaluate capping amendments will be conducted as part of remedial design assessments. Performance goals for the treatability studies will be the cleanup levels established in the ROD. The results of these treatability studies, in conjunction with site-specific parameters, will inform the design of the chemical isolation component of reactive caps (e.g., type and amount of amendment required). Treatability studies may also be required to support the design and application of sediment dewatering technologies. Treatability studies shall be conducted in accordance with EPA's *Guide for Conducting Treatability Studies under CERCLA* (EPA 1992), and a treatability study WP shall be provided for EPA approval.

5.2 Remedial Design Evaluations

5.2.1 Dredge Prism Evaluation and Equipment Selection

Dredge prism boundaries for removal of sediment exceeding RALs and PTW thresholds shall be designed based on ROD requirements. Additional dredging may be needed to accommodate caps, and the lateral extents of dredging shall be determined based on location of sediment contamination and site-specific capping requirements, as applicable. The vertical extents of dredge prisms will be based on the Technology Application Decision Tree in Figure 28 of ROD

Appendix I. Section 14.2.9.2 of the ROD provides additional details on dredging requirements. The dredge prism evaluation shall account for geotechnical considerations, debris removal, and existing structures. Releases to the water column associated with dredging will be minimized through operational best management practices (BMPs) and engineered control measures. Detailed design considerations provided in the *Technical Guidelines for Environmental Dredging of Contaminated Sediments* (USACE 2008a) shall be followed. Confirmation sampling during and after dredging shall be conducted to confirm that cleanup meets the performance standards summarized in **Table 3-1**. Dredging design requirements and characterization needs are summarized in **Table 5-1**.

A range of equipment is available for the removal of contaminated sediments, including cable- and fixed-arm excavators for mechanical dredging and hydraulic dredges. Mechanical excavation using conventional land-based excavation equipment during low water conditions or following dewatering within an enclosure is also a sediment removal option. Mechanical dredges may be fitted with clamshell buckets or enclosed (environmental) buckets. Hydraulic dredges may be fitted with various cutterheads (e.g., conventional or swinging ladder) or horizontal augers. Selection of dredging equipment shall be based on site-specific conditions, including: water depth and the slope of the sediment bed; the nature and density of the debris expected to be encountered; the physical characteristics of the sediment bed, including water content, grain size, and the presence of hardpan or bedrock; site infrastructure, including docks and bulkheads; hydrodynamic conditions, including water velocity; and the characteristics of the contamination to be removed, including the presence of NAPL.

5.2.2 Capping Design Evaluation

Capping design evaluations will determine the cap footprint and location of caps, appropriate thickness of caps to provide physical isolation, the chemical isolation component, and the erosion protection layer. Capping footprint and location should be identified through implementation of the Technology Application Decision Tree based on remedial design data. The physical isolation component of the cap must be of sufficient thickness and constructed of appropriate materials to prevent exposure of benthic and other aquatic organisms to contaminated sediment and groundwater/porewater through direct contact and ingestion. The chemical isolation component will include evaluation of cap characteristics and reactive amendments required to control the migration of contaminants under fate and transport mechanisms such as advection, diffusion, dispersion, biodegradation, and bioturbation. Design of the erosion protection layer is discussed in **Section 5.2.3**. All caps will be designed to be protective of human health and the environment.

The reactive caps described in the ROD will require the use of reactive amendments, such as activated carbon or organoclay, and the appropriate amendment will be selected based on results of the treatability studies and chemical analyses. Organoclay is more suitable for caps in areas with NAPL, while activated carbon is more effective in sequestering dissolved contaminant concentrations. Additional considerations to ensure the cap is effective for the 100-year design life should also be included in this evaluation. Detailed guidance on cap design may be found in EPA's *Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In-Situ Subaqueous Capping of Contaminated Sediments* (EPA 1998). Cap design modeling is discussed in **Section 5.2.5**. Capping design requirements and characterization needs are summarized in **Table 5-2**. For application of thin caps in areas with isolated RAL exceedances of PeCDD that are below PTW thresholds, refer to **Section 1.4**.

5.2.3 Erosion Evaluation

The erosion evaluation should include an assessment of the erosion protection layer needed to protect caps against erosive forces from river current/flood impacts, wave impacts, propeller wash, and other causes. This evaluation will determine the characteristics of the erosion protection layer, including armor layer thickness and material sizing, based on guidance provided in EPA 1998. This is of greater significance in high energy areas where capping is proposed.

Erosive forces created by river currents during the 100-year flood shall be evaluated to design the appropriate armor layer thickness and armor material size as described in EPA guidance (EPA 1998). A site-specific hydrodynamic model may be used to simulate erosive forces under flood conditions. Wave impacts will be evaluated based on maximum wind speeds and the maximum wake generated by expected vessel traffic. The erosive effects or potential scour because of propeller wash will be evaluated using information collected on the types of vessels expected in the area and the propeller type, diameter, engine horsepower, and vertical distance from the propeller to the cap. Vessel information was previously collected by the Lower Willamette Group (LWG) and can be found in Appendix Hc of the Portland Harbor RI/FS (LWG 2012).

5.2.4 Geotechnical Evaluation

Once the physical, chemical isolation, and erosion protection components of a cap have been designed, a geotechnical evaluation following methods described in EPA guidance (EPA 1998) needs to be conducted to evaluate the following aspects of a constructed cap:

- Consolidation
- Sediment stabilization/filter design
- Slope stability
- Bearing capacity

A cap consisting primarily of fine-grained material is more susceptible to consolidation than a cap with coarser material. Consolidation of cap materials can lead to a reduction in cap thickness, which should be given consideration in designing the cap thickness. In addition to cap consolidation, the consolidation of underlying sediments due to cap placement may also occur, which can lead to an upward advective flux of contaminated porewater. These are important considerations to be included in cap design and modeling. Another important mechanism of contaminant transport is the migration of sediment particles vertically through the cap if voids are present. This can be avoided by designing a cap to stabilize sediments with the use of well-graded materials in the filter design to prevent the vertical movement of solid particles carrying contamination with them.

If the cap is being placed on a slope, slope stability criteria established in EPA guidance (EPA 1998) shall be followed. Models such as Slide may be used to evaluate slope stability of the cap and underlying sediments. A minimum factor of safety of 1.5 is recommended to be used because of variability in material properties, construction practices, and localized site conditions. Per the ROD, the slope should not only maintain stability but also promote establishment of habitats. The caps shall also be designed to be stable under seismic conditions.

The underlying sediments should be able to support the weight of the cap and allow the cap to function as designed. Cap placement can result in an unbalanced load on sediments due to variations in lift thickness. These loads are more pronounced at the edge of the cap. A bearing capacity analysis shall be conducted to determine the critical height difference for cap thickness that will lead to an unbalanced load on underlying sediments. The evaluation will determine if this critical height is achievable with existing cap construction techniques.

5.2.5 Seismic Design Evaluation

ROD Section 14.2.9.1, Capping Design Requirements, states, "Caps will also factor in appropriate earthquake design elements for contingency level events." The contingency level event for design of sediment caps is defined herein as a Contingency Level Earthquake (CLE). The seismic hazard level for the CLE is defined as a ground motion with a 10% probability of exceedance in 50 years (i.e., a return period of 475 years).

Seismic cap design should include analysis of the likelihood that the cap will be damaged to the extent that underlying contaminated sediment is exposed during the CLE hazard level. The cap designs should consider an appropriate range of seismic sources that contribute to the probabilistic hazard. If the analysis determines that underlying contaminated sediment would not be exposed, the cap design meets the intended structural performance objectives for the sediment cap under seismic conditions and requires no further seismic evaluation. If a CLE is expected to expose contaminated sediment underlying the cap, then mitigating measures to avoid exposure of capped materials during a CLE event should be evaluated and incorporated into the design where practical.

Examples of local standards of practice for seismic design of structures on transportation projects, discussions of seismic design principles and approaches, and other references for seismic analysis applicable to design of sediment caps can be found in the Oregon Department of Transportation *Geotechnical Design Manual* and the Washington State Department of Transportation *Geotechnical Design Manual*, currently available at these respective links:

https://www.oregon.gov/ODOT/GeoEnvironmental/Pages/Geotech-Manual.aspx

https://wsdot.wa.gov/Publications/Manuals/M46-03.htm

If mitigating measures evaluated as part of cap design are deemed impractical to implement or ineffective in preventing exposure of contaminated sediment under the cap, a maintenance and repair plan should be incorporated into the long-term operations and maintenance plan for those caps. The maintenance and repair plan should establish cap monitoring frequency and methods, proposed ground motion triggers for post-event cap inspections, target durations for cap repair after damaging earthquake events, and any other appropriate measures to be applied over the defined long-term monitoring period.

5.2.6 Modeling Evaluations

Hydrodynamic modeling shall be conducted to identify and minimize flood rise impacts due to the constructed remedy. A Hydrologic Engineering Center – River Analysis System (HEC-RAS) model shall be used for these evaluations. Further details are discussed in **Section 5.2.11**.

The cap modeling will evaluate the effectiveness of both reactive and nonreactive caps at isolating contamination below the cap for the design period of 100 years. The model and version being used for such evaluations shall be clearly identified in design documents and should be able to evaluate numerous fate and transport mechanisms such as advection, diffusion, dispersion, bioturbation, and biodegradation. Results of the cap modeling should confirm that the cap can keep COC concentrations in the top 30 centimeters of the sediments and in associated porewater below the cleanup levels for the design period of 100 years. Accurate, site-specific chemical and seepage data shall be used as inputs to the model, and any modeling inputs that are not measured parameters shall have proper citations for values being used in the model.

Additionally, for reactive caps, the modeling shall be used to determine the amount of an amendment (e.g., activated carbon or organoclay) to be included in the cap to reliably contain contaminants for the design period. Multiple modeling scenarios should be run using different types and amounts of reactive amendments to determine the optimal amount of an amendment to be used under the site-specific physical and chemical conditions. The results from the treatability studies should be used to inform the modeling of the reactive caps.

5.2.7 Bioturbation Depth Evaluation

Bioturbation is the mixing and cycling of sediments by benthic organisms, and the depth of the bioturbation zone at the Site was measured to be generally 10 to 20 centimeters deep during the RI (ROD Section 7.4.1). Because this may vary, depending on the SMA, a bioturbation evaluation may be conducted to determine the biologically active zone based on the benthic communities present at a specific SMA. In the absence of project area-specific data, to be conservative, 20 centimeters will be used as the depth of bioturbation in cap design. Based on existing guidance (EPA 1998) the minimum thickness of a cap cannot be less than the bioturbation depth or the contamination will not remain contained and can be brought to the surface by benthic organisms. Specific guidance provided in EPA 1998 shall be followed to design the bioturbation component of the cap based on site-specific bioturbation depth determined during remedial design evaluations.

5.2.8 Dredge Material Dewatering and Water Treatment Evaluation

The volume of excess water that is expected to be generated during haul barge loading and transport shall be determined. Dewatering the dredged sediments may be necessary to facilitate transport or to meet requirements for disposal at a facility. Evaluations shall be conducted to determine the most efficient type and amount of dredge material dewatering amendment (e.g., Portland cement, fly ash, lime kiln dust) and the optimum point of addition (e.g., on the barge, at the offloading facility). If hydraulic dredging is contemplated, filter cloth selection may also be included in these evaluations if filter presses are planned for sediment dewatering. Bag tests and treatability studies may be required if geobags are planned for sediment dewatering. Water treatment technologies and methods for wastewater management on the haul barges, at the offload facility, and at the landfill (if required) shall be evaluated to ensure contaminated water from dredged material meets regulations.

5.2.9 Functional Structures Evaluation

ROD Section 14.2.9.2. states, "Structures may be removed to access contaminated media unless it can be demonstrated that the structure is permanent (e.g., not floating or movable), functional (e.g., not beyond its design life and/or in disrepair) or needed for current or future property and waterway use." This determination shall be made by the PP for each structure within the remedy footprint, and the effects of such structures on the remedy implementability and effectiveness shall be evaluated. Any impacts to the permanent, functional, or needed structures should also be considered during remedial design. Each shoreline and in-water structure shall be reviewed to determine if it is to be removed or not.

5.2.10 Riverbank Evaluation

Existing upland source information shall be reviewed to determine if any data gaps exist that may restrict the evaluation of riverbanks. The ROD defines riverbanks as areas from top of bank down to the river. Remediation of contaminated riverbanks is part of the selected remedy where it is to be conducted in conjunction with the in-river remedial actions and to protect the remedy. Other riverbanks may be included in the remedial action if contamination contiguous with contaminated river sediment is found during remedial design sampling. Remedial sampling shall be conducted to identify other riverbanks that may require remediation. Vertical and lateral extents of contamination in riverbanks shall be delineated based on available sampling data, and additional samples may be taken to support this exercise. Potentially erodible riverbanks should also be identified and evaluated based on sampling data. Any structures at riverbanks shall be evaluated in a manner consistent with ROD requirements for structures. Additional information regarding the evaluation of riverbanks is provided in **Appendix D.**

5.2.11 Flood Impact Evaluation

A flood impact evaluation is required to ensure compliance with state regulatory requirements for flood rise management and to be consistent with the Executive Orders for Floodplain Management (Executive Orders 11988 and 13690) and FEMA regulations in 44 Code of Federal Regulations (CFR) Part 9 and 44 CFR 60.3(d)(2) and (3). A HEC-RAS model shall be run on a project area and Sitewide basis during remedial design to verify that the remedy will not result in adverse impacts to the floodway. As stated in the ROD, "The Site-wide and SMA-specific evaluations of flood rise will need to consider 500-year flood elevation and freeboard and be based on the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding." The objective of this evaluation is to ensure the selected remedy does not result in unacceptable flood rise and to minimize the use of remedial process options that result in a net increase of fill material placed within the river and adjoining floodplain.

5.2.12 Climate Change Resiliency Evaluation

Climate change is expected to result in changes to the hydrology (both in seasonal patterns of river flow and peak storm event flows) in the Willamette and Columbia Rivers, as well as sea level rise (SLR), and thus impact remedy design. Vulnerable remedy components include erosion protection measures used in caps and various engineering measures used for shoreline stabilization. Resilient remedy design can be achieved by consideration of the following climate change impact factors and recommendations:

- Climate change projections and emissions scenario – Climate change and hydrologic projections are periodically updated by the Intergovernmental Panel on Climate Change (IPCC) and Climate Impacts Group (CIG) at the University of Washington, respectively. It is recommended that the remedy design consider the latest projections available at the time of design and for a reasonably conservative scenario to be determined in consultation with EPA.
    - Future design conditions for flow rate – The hydrologic projections developed by CIG for the selected emissions scenario should be used to develop river flow rate corresponding to the remedy design condition (100-year storm). CIG hydrologic projections are available at https://cig.uw.edu/resources/data/cig-datasets. Identification of the appropriate reports/datafiles and availability of flow projections for the latest IPCC climate projections at the time of design may require coordination with CIG.
    - SLR – SLR projections should be based on the same emissions scenario considered for the hydrologic projections, and may be obtained from either USACE at http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html or from the National Oceanic and Atmospheric Administration at https://coast.noaa.gov/digitalcoast/tools/slr.html.
- Planning horizon – The planning horizon depends on the availability of suitable hydrologic and SLR projections, and the design life of the remedy. The recommended planning horizon of year 2100 maximizes the design life given the climate change scenarios and projections currently available.
- Backwater effect from Columbia River – The backwater effect from the Columbia River into the Willamette River in the future depends on factors such as the mean sea level, storm surge, tide, and freshwater flow in the Columbia and Willamette Rivers. A regional-scale numerical hydrodynamic model that includes inputs for river flow rates in Willamette and Columbia Rivers, tides, and SLR for the selected emissions scenario and planning horizon can appropriately represent the future backwater effects.
- Modeling framework – Regional-scale hydrodynamic models developed by the U.S. Geological Survey (USGS) (Wherry et al. 2018) for climate change impact assessments in the 2040s time-horizon represents a single sitewide model that can be adapted to develop resilient remedy design parameters for individual project areas with a few recommended modifications as described below:
    - Planning horizon – The USGS application only considered climate change impacts for the 2040s. Therefore, the model inputs may need to be updated for the selected planning horizon for a resilient remedy design.

- Model validation – The USGS application relied on model calibration to water levels at a few locations in the model domain. To support application for resilient remedy design at the Site, model performance for site currents and water levels should be validated.

- Grid resolution – Depending on the resolution of the existing computational grid, application of the USGS model for resilient remedy design at the Site may require refinement of the grid.

It should be noted that not all the impact factors listed above need explicit consideration for resilient design. For example, a more conservative design may be achieved by using the current sea level instead of the future sea level. Similarly, assumptions resulting in more conservative remedy design may also be applicable in the context of the modeling framework. These and potentially other simplifications may be determined and adopted in consultation with EPA.

5.2.13 Sufficiency Assessment

A sufficiency assessment shall be conducted to evaluate upland and in-water sources of contaminants to determine whether they have been adequately investigated and sufficiently controlled or considered such that the remedial action can proceed. The sufficiency assessment shall consider potential impacts from a range of potential sources, including upland pathways (direct discharges, groundwater, riverbank, stormwater, and overwater), in-water sources of recontamination, resuspension of sediments from natural and anthropogenic activities, factors that may impact sediment cap effectiveness, potential future use for near shore land and in-water uses, and other future conditions (e.g., climate change impacts) that may impact recontamination potential.

The results of this evaluation shall be presented in a sufficiency assessment report to be submitted to EPA for review and approval. This report shall include an interpretation of the data relative to the sufficiency of upland and in-water source controls to reduce the potential for recontaminating the selected remedy following implementation. The assessment will consider the magnitude of the recontamination effects and discuss implications to the selected remedy for the project area. The discussion will also present the limitations of the assessment approaches and any remaining data gaps.

A sufficiency assessment summary table shall be included with the report that explicitly identifies the potential sources and pathways at the project area and categorizes the status of each source using the outcome categories: sources are sufficiently controlled, sources are conditionally controlled, and sources are not sufficiently assessed or controlled. An example table developed by DEQ is provided in **Appendix E**. The goal of this table is to serve as the basis for EPA's sufficiency determination in informing respondents whether cleanup can proceed and, if potential sources remain, how those sources should be integrated into the in-water design. The sufficiency assessment summary table shall be updated and included in the pre-final (95%) remedial design as a final check to ensure remediation can commence.

5.2.14 Habitat Impact Evaluation

Habitat impacts due to remedy implementation shall be evaluated to demonstrate compliance with action-specific or location-specific applicable and relevant or appropriate requirements

(ARARs), including the Clean Water Act (CWA) Section 404(b)(1) and the Endangered Species Act (ESA). The selected remedy needs to be compliant with the ESA because threatened or endangered species migrate through and use the Site and the Site contains designated critical habitat for such species. Remedial actions cannot jeopardize the continued existence of endangered or threatened species. Additionally, the Magnuson Stevens Fishery Conservation and Management Act provides for the designation of Essential Fish Habitat (EFH) for waters and substrate necessary for commercially fished species to spawn, breed, feed, or grow to maturity. Actions that may adversely affect EFH need to be coordinated with NMFS. EPA intends to follow the recommendations of NMFS, to the extent feasible, to avoid or minimize impacts to habitat.

The habitat evaluation shall be included in the project area-specific biological assessment (BA), which shall determine whether remedial actions may adversely affect critical habitat, listed species, and EFH. The BA will also contain BMPs and other mitigation measures to minimize impacts during and after construction of the remedy. For the purpose of conducting the habitat evaluation, data gaps in existing information will be filled by remedial design sampling and surveys. Measures to mitigate adverse impacts may include the time of year and duration of in-river work to be conducted.

5.2.15 Clean Water Act Analysis

An analysis is required to demonstrate the proposed remedial action is compliant with CWA 404(b)(1) guidelines and other substantive requirements of the CWA and Oregon's water quality standards. This analysis shall evaluate the physical, chemical, and biological impacts to the aquatic environment and determine the need for compensatory habitat mitigation measures. A memorandum shall be prepared to supplement the information from the FS regarding long- and short-term impacts of the remedial action at the project area, minimization of adverse effects, compliance with the ROD, and need for mitigation. Because remedial actions may result in the discharge of dredged or fill material to waters of the United States, the remedy must avoid or minimize impacts to the aquatic environment. Both the CWA and Oregon's water quality standards require that any activity during the implementation of the remedy that may result in a discharge to waters of the state requires reasonable assurance of compliance with water quality standards. Therefore, remedial activities will be conducted in a manner that will not violate applicable water quality standards by implementing necessary effluent and other limitations, and monitoring requirements. Short-term exceedances of some water quality criteria are likely during capping, dredging, pulling pilings, removal of structures or debris, and/or residual management material; therefore, the application of BMPs (e.g., stormwater and construction BMPs) and engineering control measures are required to meet the prescribed water quality standards. Pertinent water quality-specific information will be considered during remedial design and a water quality monitoring plan will be developed to document requirements to comply with these ARARs.

The selected remedy is designed to avoid or minimize adverse impacts to aquatic resources and waters of the United States, and compensatory mitigation is to be considered only after other options to minimize impacts have been considered. Compensatory mitigation entails the restoration, establishment, enhancement, and/or preservation of wetlands, streams, or other aquatic resources conducted specifically to offset authorized unavoidable impacts to these resources. Where the remedial action adversely impacts habitat, caps will be designed to minimize impacts and restore the surface for habitat function by backfilling to existing elevations and/or using beach mix to provide appropriate substrate. If permanent or temporary loss of habitat does occur, compensatory mitigation shall be undertaken. Per the ROD, armored caps within shallow water areas and on riverbanks will likely result in unavoidable impacts. However, any further loss and mitigation requirements are to be identified in coordination with NMFS and USFWS during remedial design.

5.3 Remedial Design Considerations

5.3.1 Community Impacts

Per the ROD responsiveness summary, Section 2.2.6, "Cleanup activities, including the use of dredges and barges generally should be consistent with existing uses of the river in terms of the level of noise, lighting, and human activity." Concerns about air quality, noise, odor, light, and other potential community impacts will be considered and minimized to the extent possible. Exceedances of health-based standards may result in additional controls being put in place so that construction impacts are mitigated to the extent practicable. EPA will provide contact information for community members to raise complaints or concerns during construction.

Mitigation measures and BMPs shall be implemented to protect the community, workers, and the environment during construction of the remedial action. Examples of these measures include:

- Limiting access to sediment processing at any upland treatment and transfer facility areas to authorized and trained personnel
- Reasonable precaution to control fugitive emission of air contaminants in accordance with Oregon Administrative Rule (OAR) 340-226
    - Emission of airborne particulate matter shall be controlled to address OAR 340-208
    - Dust suppression shall be maintained, as necessary, to eliminate air contaminant migration during remedial action in compliance with general emissions standards and fugitive emission requirements
    - Air monitoring may be required to ensure contaminants that volatilize will not exceed acceptable health-based concentrations and adversely affect local communities and workers
- Pollution controls to minimize and control spills, emissions, and odors from construction activities
- Cleanup activities with the potential to restrict navigation in the harbor channel coordinated with USACE, the U.S. Coast Guard, and other stakeholders during remedial design
- Engineering and navigation controls (established by the dredging and/or materials management contractor working in coordination with the U.S. Coast Guard and other entities) to mitigate increased river traffic

- Isolating work areas with an adequate buffer zone so that pleasure craft and commercial shipping can safely avoid construction areas

Fish consumption advisories will continue until RAOs are achieved. COC concentrations in fish tissue are expected to increase during the multiyear construction period; however, this will mainly occur during the in-water work window of July 1 through October 31.

5.3.2 Use of Green Remediation Practices

ROD Section 14.2.12 addresses the use of green remediation practices in the description of the selected remedy. To the extent practicable, the remedial action should be carried out consistent with EPA Region 10's Clean and Green policy (EPA 2009) and the Superfund Green Remediation Strategy (EPA 2010b), including the following practices:

- Use renewable energy and energy conservation and efficiency approaches, including Energy Star equipment
- Use cleaner fuels such as low-sulfur fuel or biodiesel, diesel emissions controls and retrofits, and emission reduction strategies
- Use water conservation and efficiency approaches, including Water Sense products
- Use reused or recycled materials within regulatory requirements
- Minimize transportation of materials and use rail rather than truck transport to the extent practicable

EPA will limit impacts to the community from performance of the cleanup itself by considering BMPs that limit the overall environmental footprint of the response, including the following practices:

- Use renewable energy sources
- Limit idling of trucks and equipment
- Rely on local sources of materials
- Ensure trucks, barges, and railcars are full prior to transport
- Route trucks in a manner that avoids schools or upgrades to road facilities to increase safety in the context of increased truck traffic
- Implement on-site dust and noise control to reduce air pollutant and greenhouse gas emissions
- Require clean fuel and emissions control retrofit incentives in construction contracts

Measures shall be developed during the design process to reduce impacts to habitat as part of the cleanup, and there will be a need for compensatory mitigation where loss occurs. Additionally, by reducing contaminant levels in surface water and sediment, EPA expects to increase the opportunity for healthy recreational activities (e.g., boating, swimming, fishing) in the Lower Willamette River, thus contributing to the overall health of the community.

A green remediation plan shall be prepared by the PP as part of the remedial design phase of the project area for each action. The plan will discuss how resource impacts will be mitigated to the extent possible. For example, rail and barge transport of wastes should be used when feasible to limit greenhouse gas emissions and lessen neighborhood impacts for air toxics such as nitrous and sulfur oxides, consistent with EPA national and regional guidance. Where trucking cannot be avoided, the plan will discuss optimum haul routes to minimize diesel exhaust exposure (known to cause childhood asthma) to sensitive subpopulations, such as residential streets near schools.

5.3.3 Navigation Channel Requirements

USACE is responsible for maintaining the Lower Willamette River federal navigation channel (FNC) to a depth of -42 feet CRD, which includes 2 feet of overdredge to accommodate advance maintenance or overdepth dredging as needed. However, Congress has authorized USACE to improve and deepen the Lower Willamette River FNC to -45 feet CRD, which includes 2 feet of overdredge. Deepening of the Lower Willamette River FNC has been postponed until a remedy is implemented. To account for this future change, all remedial designs will use -45 feet CRD as the congressionally authorized FNC depth.

Based on the authorized FNC depth and dredging technology constraints, remedial designs involving capping must incorporate at least a 2-foot buffer, such that cap elevations within the FNC must not exceed -47 feet CRD. To ensure USACE authority to maintain the FNC is not impeded, PPs will engage in site-specific coordination with EPA and USACE as needed.

In addition, remedial designs in and immediately adjacent to the FNC will incorporate at least a 50-foot lateral buffer to enable USACE to carry out overwidth dredging, including side slope sloughing from maintenance dredging to -45 feet CRD, as needed. If a 50-foot lateral buffer is not feasible because of site-specific constraints, PPs in remedial design will coordinate with EPA and USACE to assess future dredging requirements in light of deepening, side slope stability, equipment, and layback requirements.

5.3.4 Construction BMPs for Minimizing Resuspension and Release

Release is the mechanism by which dredging operations result in transfer of contaminants from sediment porewater and sediment particles into the water column or air. Dredging BMPs, such as silt curtains or sheet pile walls, shall be used to minimize releases to the water column. Monitoring of water quality parameters by the PP will be conducted to measure the effectiveness of these controls and to determine whether additional control measures may be required. The monitoring program will include surface water and air (where necessary).

Sheet piles are a representative, engineered, rigid control measure identified and evaluated for sediment dispersion control. However, that representative approach does not preclude other types of BMPs for consideration during remedial design. Details regarding sediment dispersion control and location-specific engineered rigid control measures shall be determined during remedial design. *The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk* (USACE 2008b) guidance should be used as a guide when evaluating resuspension, releases, and resuspension during dredging operations.

5.3.5 Post-Remediation Confirmation Sampling for Dredging

Confirmation samples will be collected in each dredge management unit (DMU) as soon as possible after attainment of the depth of contamination elevation in 95% or more of the dredge prism area. DMUs will be proposed during remedial design based on site-specific conditions including the distribution of contamination, physical characteristics of the dredge area, equipment selection, and expected production rates. Documentation shall be provided to EPA for verification. Additional information on this topic is provided in **Appendix B**.

5.3.6 Materials Handling, Transport, and Disposal

All dredged materials and contaminated riverbank materials removed from the Site under the selected remedy will be managed under dredge material management Scenario 2 (outlined in ROD Section 10.1.1.4) and disposed of in an off-site landfill. Data collected during remedial design will initially be used to inform the appropriate materials handling, transport, and disposal of dredged sediment and excavated soil. A materials management plan (MMP) shall be incorporated into the remedial design and should describe items such as the following:

- Means and methods, including recordkeeping, to demonstrate compliance with substantive requirements of ARARs identified in the ROD for waste handling work conducted within the Site.
- Means and methods, including recordkeeping, to demonstrate compliance with substantive and administrative requirements of applicable federal, state, and local laws and regulations for work conducted off-site, including transload, transport, and waste disposal.
- Dredge sediment characterization and classification approach for off-site transport and disposal. The approach proposed shall demonstrate compliance with substantive and administrative requirements of applicable federal, state, and local laws and regulations for off-site transport and waste disposal.

The following subsections describe information that needs to be collected and considered for the purpose of designing and implementing the material handling, transport, and disposal procedures.

5.3.6.1 Dredged/Excavated Material Handling and Transport

As stated in the ROD, material was assumed to be mechanically dredged; loaded directly into barges; and transported for dewatering, treatment, or further transport. Riverbank materials excavated from above the water line were assumed to be loaded directly into containers or barges for transport and treatment as needed. Other sediment removal methods, such as hydraulic dredging and excavation using conventional land-based excavation equipment during low water conditions or following dewatering within an enclosure excavation, may be considered during remedial design. In either case, the most effective methods for removal, material handling, and transport shall be determined during remedial design.

For purposes of designing and implementing material handling and transport, site-specific data collection needs, such as the following, should be considered:

- Sediment characteristics (physical and chemical properties)

- Site conditions (e.g., tidal influences, current)
- Technological developments and equipment innovations
- Bathymetric survey
- Sediment release and resuspension control
- Dredge and excavation equipment selection
- Dewatering considerations
- Site access considerations
- Maneuverability concerns, including proximity to utilities and other infrastructure, narrow channel widths, surface and submerged obstructions, and overhead and other site access restrictions such as bridges
- Navigation channel considerations
- Debris, loose rock, and vegetation
- Ecological considerations and coordination with USFWS
- Transload facility location
- Modes of transportation
- Transportation routes

The *Technical Guidelines for Environmental Dredging of Contaminated Sediments* (USACE 2008a) should be used as a guide when evaluating: site conditions and sediment characteristics; environmental dredging performance standards; equipment capabilities and selection; production, project duration, and transport; methods for estimating resuspension, residuals, and release; control measures; and operating methods and strategies.

5.3.6.2 Waste Disposal

The disposal of waste generated from dredging and excavating material is impacted by state and federal ARARs. Regulatory requirements influence the need for treatment (e.g., RCRA land disposal restrictions).

As part of an MMP, a characterization and classification approach should be presented to demonstrate compliance with substantive requirements of applicable federal, state, and local laws and regulations for transport and waste disposal outside of the Site. This approach should include a process for determining whether the dredged sediment contains RCRA-listed or characteristic hazardous waste, Toxic Substances Control Act (TSCA) waste, and/or State of Oregon-listed hazardous waste. The discussion of the means and methods for the classification process, including procedures for requesting any required approvals from DEQ such as “contained in” determinations, should be presented. Depending on the characterization and classification of the material, the approach should include landfill worker safety, equipment decontamination, recordkeeping, and other requirements.

RCRA Compliance

Analytical testing results shall be used to: (1) determine whether material generated from dredging and excavation potentially contains a listed hazardous waste and/or exhibits a characteristic of hazardous waste; and (2) address the information needs of the receiving facility (or facilities) for accepting, handling, and disposing of materials. Sample analysis using the toxicity characteristic leaching procedure (TCLP) is necessary for determining whether a solid waste exhibits the characteristic of toxicity in accordance with 40 CFR.261. As an alternative to the TCLP, soil or sediment can be evaluated for the characteristic of toxicity based on total concentrations of contaminants, following the procedure discussed in EPA's hazardous waste test methods frequently asked questions found at https://archive.epa.gov/epawaste/hazard/web/html/faq_tclp.html.

The process for identification of hazardous waste should address all ARAR-related considerations for waste classification. For instance, extremely high pH (which could occur from excessive quicklime treatment) could result in characteristic hazardous waste. Another example is F-listed waste, which stays listed regardless of TCLP concentrations except under specific circumstances. The testing framework should be reviewed and revised to account for all waste characterization requirements under ARARs and disposal facility waste acceptance requirements, and applicable federal, state, and local regulations and requirements for off-site disposal.

Characteristic hazardous wastes that are generated (e.g., dredged/excavated) and land disposed are subject to the land disposal restriction regulations in 40 CFR 268. Hazardous waste that contains underlying hazardous constituents exceeding the universal treatment standards but do not contain underlying hazardous constituents exceeding 10 times the universal treatment standards for soil or sediment are eligible for direct landfill disposal at a RCRA Subtitle C facility compliant with applicable federal, state, and local regulations and requirements. Alternative treatment standards are provided in 40 CFR 268.40.

Nonhazardous dredged materials (as defined under RCRA) are eligible for direct landfill disposal at a RCRA Subtitle C or D facility if in compliance with the individual acceptance criteria of the receiving facility. The Roosevelt Regional Landfill was selected in the FS as the representative commercial landfill (RCRA Subtitle D facility); however, the MMP can identify other existing Subtitle D facilities as long as they are compliant with applicable federal, state, and local regulations and requirements.

Data collected during remedial design will initially be used to inform the appropriate disposal site. The MMP shall provide the necessary ARAR compliance documentation. The MMP shall define recordkeeping requirements to document that RCRA substantive requirements are being met and that container requirements and storage requirements consistent with RCRA will be implemented during construction and operation of the waste handling facilities. For example, RCRA hazardous waste has a 90-day holding time.

Oregon Solid Waste, Hazardous Waste, and Hazardous Materials

OAR 340-093-0210 and 0220 provide solid waste general provisions regarding storage and collection of solid waste and transportation-related requirements for trucks servicing a solid waste collection facility. Applicable requirements for operation of an on-site transloading facility for dredged materials slated for off-site disposal shall be determined. State-listed hazardous waste may be present offshore within the River Mile 7W project area. Hazardous waste generated during remedial actions may be treated and temporarily stored at transload facilities, pending final transport and disposition. The MMP should address how state treatment and storage regulations will be complied with during the construction and operation of the transload facilities.

TSCA

All waste generated as a result of remedial actions shall be sampled for PCBs, and any TSCA waste containing greater than 50 milligrams per kilogram PCBs will have to meet TSCA requirements during transport and off-site disposal. The Chemical Waste Management facility in Arlington, Oregon, is permitted to accept TSCA waste (RCRA and TSCA EPA ID Permit ORD089452353); however, the MMP can identify other existing facilities as long as they are compliant with applicable federal, state, and local regulations and requirements. The MMP shall address proper handling and disposal of any TSCA waste generated during remedial actions.

5.3.6.3 Treatment Considerations

RCRA characteristic hazardous wastes are regulated somewhat differently from listed hazardous wastes because a characteristically hazardous waste that is "decharacterized" as a result of treatment can be disposed of in nonhazardous, solid waste land-based units (i.e., Subtitle D landfills). When a characteristic hazardous waste is decharacterized, it no longer exhibits a hazardous waste characteristic. Characteristic wastes cannot be land disposed until they meet all applicable treatment standards for the waste characteristic and underlying hazardous constituents that apply to the waste. Material testing shall be required to determine the extent of treatment needed to decharacterize the waste. In addition to decharacterizing characteristic hazardous waste, testing related to free liquids shall be performed to support an evaluation of dewatering amendments, as discussed in **Section 5.2.7**.

The need for and extent of ex situ treatment shall be identified in the MMP based on the off-site disposal requirements and material testing during design and construction. All dredged/excavated material shall be tested to determine the appropriate disposal option, the need for treatment prior to disposal, and the appropriate type of treatment amendment necessary to comply with ARARs. This includes ARARs related to waste disposal requirements and facility waste acceptance requirements, and applicable federal, state, and local regulations and requirements for off-site disposal.

Section 6 Planning and Design Submittals

Planning and design submittals may vary by project area, but the planning and design documents that are typically required are described herein. The actual documents required will be identified in the SOW for each project area.

6.1 Planning Documents

Planning documents to be prepared and submitted to EPA for review and approval may include the following:

- Sufficiency Assessment Report – The objective of the sufficiency assessment is to evaluate upland (direct discharges, groundwater, riverbank, overwater) and in-water sources of contaminants to determine whether they have been adequately investigated and sufficiently controlled or considered such that the remedial action can proceed.
- PDI WP – If a PDI will be performed to fill data gaps for the remedial design, a PDI WP shall be prepared that includes an evaluation and description of data gaps. An FSP, QAPP, health and safety plan, and emergency response plan would be part of the PDI WP. If a PDI is conducted, a PDI evaluation report will need to be submitted with or prior to the basis of design report (BODR).
- Remedial Design WP – A remedial design WP shall be submitted to describe the following:
    - Plans for implementing all remedial design activities identified in the SOW
    - Overall management strategy for performing the remedial design, including a proposal for phasing of design and construction, if applicable
    - Proposed general approach to contracting, construction, operation, maintenance, and monitoring of the remedial action, as necessary, to implement the work
    - Roles and responsibilities of all organizations and key personnel involved with the development of the remedial design
    - Descriptions of any areas requiring clarification and/or anticipated problems, if any (e.g., data gaps)
    - Description of studies and design phases for any on-site transload facility to be used to transload dredged materials from the site or any other area of the site
    - Any proposed treatability studies that may be needed for the remedial design
    - Applicable permitting requirements and other regulatory requirements for the remedial design
    - Plans for obtaining access in connection with the remedial design, such as access agreements, property acquisition, property leases, and/or easements

The remedial design WP shall also include updated supporting deliverables, such as an FSP, QAPP, health and safety plan, and emergency response plan.

- Supplemental PDI WP – If additional data gaps are identified during development of the remedial design WP, a supplemental PDI WP shall be prepared to collect the remaining data needed for remedial design. If a supplemental PDI is conducted, a supplemental PDI evaluation report will need to be submitted.

- Treatability Study WP – A treatability study WP may be needed, depending on the SMA and technology selection. Treatability studies may be needed to support dewatering operations, reactive caps, or in situ treatment. If treatability studies are required, a treatability study report will need to be submitted.

6.2 Design Documents

Design documents to be prepared and submitted to EPA for review and approval may include the following:

Basis of Design Report – The BODR summarizes existing data including information collected to fill data gaps, presents an updated CSM, and provides justification for selected remedial technologies. This document will describe the objectives, overall approach, schedule, milestone check-in points, and specific elements of the BODR. EPA concurrence with the selected remedial technologies is needed prior to completion of the preliminary design. The BODR shall summarize the results of the sufficiency assessment report and whether potential sources of recontamination have been adequately investigated and controlled or considered such that the remedial action can proceed.

- Preliminary (30%) Design – A preliminary remedial design must be submitted and include the following:

  - A design criteria report, as described in the *Remedial Design/Remedial Action Handbook* (EPA 1995)

  - Preliminary drawings and specifications

  - Descriptions of permit requirements, if applicable

  - A description of how the remedial action will be implemented in a manner that minimizes environmental impacts in accordance with EPA's *Principles for Greener Cleanups* (EPA 2009), and the information described in Appendix M of the Portland Harbor FS (CDM Smith 2016)

  - Monitoring and control measures to protect human health and the environment, such as air monitoring and dust suppression, during the remedial action

  - Updates of all supporting deliverables required to accompany the remedial design WP and the following additional supporting deliverables: ICs implementation and assurance plan, waste designation memo, BA, CWA analysis, project area monitoring plan, construction quality assurance/quality control plan, transportation and off-site disposal plan, and operation and maintenance plan and manual

- A value engineering screen should be completed consistent with the *Remedial Design/Remedial Action Handbook* (EPA 1995) and EPA's Circular No. A-131, *Value Engineering (For Fund-Financed Superfund Remedial Design/Remedial Action Projects)*, OSWER 9355.5-24FS to identify how the remedial design could be modified to increase efficiency and reduce task durations and costs while meeting project objectives that are consistent with the ROD. The results of the value engineering screen should be included as an attachment to and concurrent with the preliminary design. Depending on the results of the screen, a value engineering study may be required. If a value engineering study is required, it should be completed consistent with the *Remedial Design/Remedial Action Handbook* (EPA1995) and EPA's Circular No. A-131, *Value Engineering (For Fund-Financed Superfund Remedial Design/Remedial Action Projects)*, OSWER 9355.5-24FS. The results of the study should be included as an attachment to the intermediate remedial design and should document methods to improve the remedial action and optimize implementation.

- Design specifications for any transload facility to be used on-site for transferring dredged materials from the project area, including specifications and information for any transload-specific ARARs that must be complied with to build and operate the transload facility. In addition, the design specifications must address the following: (1) location of transload operations; (2) identification of contaminated groundwater and soil within the foot print of the transload operations; and (3) plans to remove or remediate these contaminated media during construction of the transload facility, or an analysis of how the presence and operation of the transload facility will not inhibit or prevent implementation of ongoing source control measures and potential upland remedial measures. If an off-site transload facility will be used for dredged materials from the project area, permit application design information must be submitted for approval.

- Necessary information from owners of riverbanks and/or submerged lands that are within the project area, such as the owner's future anticipated river use that should be considered in the decision tree process and design, shipping schedules, and known buried infrastructure. The remedial design shall document in writing the landowners that were contacted and the information received for all properties in the project area.

<u>Intermediate (60%) Design</u> – The intermediate remedial design will be a continuation and expansion of the preliminary remedial design that addresses EPA's comments and includes the same elements as are required for the preliminary (30%) design.

<u>Pre-Final (95%) Design</u> – The pre-final remedial design will be a continuation and expansion of the previous design submittal and must address EPA's comments regarding the intermediate remedial design. The pre-final remedial design will serve as the approved final (100% remedial design) if EPA approves the pre-final remedial design without comments. The pre-final remedial design will include:

- A complete set of construction drawings and specifications that are certified by a registered professional engineer, suitable for procurement, and follow the Construction Specifications Institute's Master Format 2016
- Survey and engineering drawings showing existing project area features, such as elements, property borders, easements, and project area conditions
- Pre-final versions of the same elements and deliverables as are required for the intermediate remedial design
- A specification for photographic documentation of the remedial action
- Updates of all supporting deliverables required to accompany the preliminary (30%) remedial design, including an updated sufficiency assessment summary table as a final check to ensure remedial construction can commence

Final (100%) Remedial Design – Final version of all pre-final design deliverables that address EPA comments.

Section 7 References

AECOM and Geosyntec. 2019. *PDI Evaluation Report, Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling, Portland Harbor Superfund Site, Portland, Oregon.* Prepared on behalf of the Portland Harbor Pre-RD AOC Group.

Anchor QEA, LLC. 2012. *Portland Harbor RI/FS, Appendix Hc, Capping Effectiveness and Stability Modeling, Draft Feasibility Study*. Prepared for the Lower Willamette Group.

CDM Smith. 2016. *Portland Harbor RI/FS, Feasibility Study*. Prepared for the U.S. Environmental Protection Agency Region 10, Seattle, Washington.

DEQ. 2018. *Sampling Sediment and Porewater in the Lower Willamette River*. EPA GW-SW Interaction Workshop, November 16, 2018. Henning Larsen R.G., Oregon DEQ, Portland, Oregon.

EPA. 2020. *Program Data Management Plan, Portland Harbor Remedial Design Investigation – Portland Harbor Superfund Site*. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

EPA. 2019a. *EPA Review Comments on PDI Evaluation Report and Acoustic Fish Tracking Study 12-Month Addendum.* U.S. Environmental Protection Agency Region 10, Seattle, Washington.

EPA. 2019b. *Explanation of Significant Differences, Portland Harbor Superfund Site, Portland, Oregon*. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

EPA. 2017a. *Developing Sediment Remediation Goals at Superfund Sites Based on Pore Water for the Protection of Benthic Organisms from Direct Toxicity to Non-ionic Organic Contaminants*. EPA/600/R-15/289. U.S. Environmental Protection Agency, Washington, DC.

EPA. 2017b. *Record of Decision, Portland Harbor Superfund Site, Portland Oregon*. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

EPA. 2010a. *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8- Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds*. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC. EPA/100/R-10/005.

EPA. 2010b. *Superfund Green Remediation Strategy*. U.S. Environmental Protection Agency, Washington, DC. Available at https://www.epa.gov/greenercleanups/superfund-green-remediation-strategy-2010.

EPA. 2009. *Principles for Greener Cleanups*. Available at https://www.epa.gov/greenercleanups/epa-principles-greener-cleanups.

EPA. 2005. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures*. EPA/600/R-02/011. U.S. Environmental Protection Agency, Washington, DC.

EPA. 1998. *Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In-situ Subaqueous Capping of Contaminated Sediments.* EPA 905/B-96/004. U.S. Environmental Protection Agency, Washington, DC.

EPA. 1995. *Remedial Design/Remedial Action Handbook*. EPA 540/R-95/059. U.S. Environmental Protection Agency, Washington, DC.

EPA. 1992. *Guide for Conducting Treatability Studies under CERCLA*. EPA/540/R-92/071a. U.S. Environmental Protection Agency, Washington, DC.

USACE. 2008a. *Technical Guidelines for Environmental Dredging of Contaminated Sediments*. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

USACE. 2008b. *The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk*. ERDC/EL TR-08-4. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

USACE. 2003. *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual*. ERDC/EL TR-01-01. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Wherry, S.A., T. Wood, H.R. Moritz, and K.B. Duffy. 2018. *Assessment of Columbia and Willamette River Flood Stage on the Columbia Corridor Levee System at Portland, Oregon, in a Future Climate*. U.S. Geological Survey Scientific Investigations Report 2018-5161, 44 p. Available at https://doi.org/10.3133/sir20185161.

Tables

Table 3-1. Technology-Specific Performance Standards

Remedial Technology	Media	RAO	Performance Standard
Dredging	Sediment	1, 2, and 6	Achieve sediment cleanup level within upper 12 inches of the sediment bed, measured as a 95% upper confidence limit (UCL) on the arithmetic mean throughout the SMA.
		5	Achieve sediment cleanup level within upper 12 inches of the sediment bed, measured as a 95% UCL on the arithmetic mean over a DMU.
		1, 2, 5, and 6	Bathymetric or land elevation survey to confirm excavation depth and thickness of any placed material (e.g., residual management layer).
		1, 2, 5, and 6	Bucket survey designed to characterize material being placed to confirm it meets design specification (e.g., grain size, activated carbon content).
Capping	Sediment	1, 2, and 6	Achieve sediment cleanup level within upper 12 inches of sediments immediately below any armoring layer, measured as a 95% UCL on the arithmetic mean throughout the SMA.
		5	Achieve sediment cleanup level within upper 12 inches of sediments immediately below any armoring layer, measured as a 95% UCL on the arithmetic mean over a DMU.
		1, 2, 5, and 6	Bathymetric or land elevation survey to confirm thickness of placed capping materials.
		1, 2, 5, and 6	Bucket survey designed to characterize capping material being placed to confirm it meets design specification (e.g., grain size, activated carbon content).
	Groundwater/ Porewater	4	Achieve groundwater cleanup level within upper 12 inches of sediment porewater immediately below any armoring layer, measured as a 95% UCL on the arithmetic mean throughout the SMA.
		8	Achieve groundwater cleanup level within upper 12 inches of sediment porewater immediately below any armoring layer, measured as a 95% UCL on the arithmetic mean over a DMU.
Enhanced Natural Recovery	Sediment	1, 2, 5, and 6	Bathymetric survey to confirm thickness of placed capping materials.
			Bucket survey designed to characterize material being placed to confirm it meets design specification (e.g., grain size, activated carbon content).
Mitigation	Sediment and Riverbank Soil	NA	Bucket survey designed to characterize material being placed to confirm it meets design specification (e.g., grain size, organic carbon content).
			Plant survey designed to confirm that plant coverage meets the design specifications (e.g., native plant community characteristics, invasive species limits, target species presence).

Table 5-1. Dredging Design Requirements and Characterization

Design Requirement	Characterization Needed
Pre-dredge surface elevations will be determined for comparison to the post-dredge surface.	Multibeam bathymetry survey or the equivalent.
Dredging designs will consider the lateral and vertical extent of contamination to remove in-river sediment exceeding RALs and/or PTW thresholds. Note: Areas with isolated exceedances of PeCDD RAL (i.e., areas where surface sediment is contaminated with PeCDD but there are no adjacent and/or underlying subsurface RAL exceedances of other COCs) that are generally nonerosive may be allowed to use thin caps or thin reactive caps, as needed, to reliably contain PeCDD concentrations exceeding RALs and below PTW thresholds. Refer to **Section 1.4** for details.	Characterization of surface and subsurface sediment chemistry, as necessary, to delineate the lateral and vertical extent of contamination and to design the dredge prism. Sediment core spacing and sample intervals shall be sufficient to define lateral and vertical extent (e.g., 150- by 150-foot lateral grid; 1-foot sample interval where needed to define prism depth). As needed, step out locations will be advanced to delineate the extent of COCs above the applicable RALs and/or PTW thresholds. Bathymetric surveys must be conducted to provide vertical and lateral control for the dredge prism.
Dredge prism boundaries will account for geotechnical considerations, shoreline stability, and existing structures.	Site surveys to identify and assess the functionality of site structures in and near the dredging footprint. Physical and geotechnical data to design and construct dredging-based sediment remedies adjacent to or below site structures. Characterization of sediment (including physical and geotechnical tests), evaluation of side slope stability, and determination of horizontal offsets, as needed, to avoid impacting existing structures.
Dredging design will consider the presence or absence of debris.	Debris surveys to evaluate removal of debris and selection of dredging equipment.
Structures should be removed to access contaminated media unless it can be demonstrated that the structure is permanent (e.g., not floating or movable), functional (e.g., not beyond its design life and/or in disrepair) or needed for current or future property and waterway use. Minor structures, such as outfalls, will be moved to accommodate dredging and capping when necessary.	Site surveys (including utility surveys as appropriate) to identify and assess the functionality of site structures in and near the dredging footprint. Physical and geotechnical data to design and construct dredging-based sediment remedies adjacent to or below site structures.
Water quality controls, including silt curtains and/or rigid containment (e.g., sheet pile wall enclosures), may be required to minimize releases to the water column associated with the presence of contaminated sediments, NAPL, debris, and other chemical or physical conditions to comply with water quality standards.	Characterization of sediment, including physical, geotechnical, and elutriate tests and hydrodynamic surveys, as necessary, to design and construct water quality controls (e.g., sheet pile containment, silt curtain containment, BMPs) during dredging activities.
All dredged or excavated materials will be tested to determine whether treatment is necessary prior to disposal and to determine appropriate disposal locations.	Waste characterization, as necessary, to support identification of disposal requirements, including the need for treatment prior to disposal.
Additional dredging may be necessary to accommodate caps.	Multibeam bathymetry survey or the equivalent.
Evaluate potential for contaminant release during dredging operations.	Characterization of sediments, including chemical and dredge elutriate tests.
Residual management layers (amended with activated carbon, as necessary) will be placed as soon as is practicable following dredging within the dredge prism and surrounding area.	Sufficient characterization and habitat surveys to design and construct the residual management layer, including thickness, need for activated carbon or other treatment materials, and selection of appropriate grain size and carbon content to support habitat needs. Characterization of the residual management layer source material must be conducted to demonstrate it is suitable for placement.

Table 5-1. Dredging Design Requirements and Characterization

Design Requirement	Characterization Needed
Determine method and location for dredge material dewatering and handling.	Determine type and amount of dredge material to be removed and dewatering required based on dredging method selected. Characterize water content and conduct treatability testing as appropriate to determine dewatering method. Identify locations for dredge material offloading, dewatering, and treatment/disposal.

Table 5-2. Capping Design Requirements and Characterization

Design Requirement	Characterization Needed
General Capping Design Requirements	
All caps will be of sufficient thickness to prevent exposure.	Aquatic surveys to determine cap thickness (e.g., burrowing depth) to prevent exposure. In the absence of project area-specific data, 20 centimeters will be used as the bioturbation depth based on RI data.
All caps will be constructed of materials adequate to contain contamination remaining beneath the cap.	Surface and subsurface sediment data to delineate the cap footprint, characterize material to be left in place below the cap, and design and construct the cap to prevent migration through the cap.
All caps will be constructed with sufficient armor material to remain in place when subject to erosive forces resulting from wind- and vessel-generated waves, current, or propeller wash. Note: Thin caps to reliably contain isolated PeCDD concentrations exceeding RALs and below PTW thresholds may not require armor material because they will be applied in areas that are generally nonerosive. Refer to **Section 1.4** for details.	Bathymetric surveys and waterway use and hydraulic data, as necessary, to support the hydrodynamic modeling required to design and construct erosion protection layers.
All caps will be constructed to minimize adverse effects on the in-river and riparian habitat, including the loss of shallow water habitat.	Bathymetric, aquatic habitat, and riparian surveys to support identification of habitat areas and identify suitable cap cover material that will minimize adverse effects on in-water and riparian habitat.
Cap Placement Design Requirements	
In habitat areas, currently defined by NMFS as those areas above -15 feet CRD, post-remedy surfaces will be maintained at their current depth and backfilled or capped with suitable habitat materials.	Bathymetric and riparian surveys to support identification of habitat areas.
Cap construction will consider the ability of the sediment bed to support the cap during placement.	Geotechnical testing to evaluate sediment bed stability.
Caps will also be designed to withstand more frequent floods with higher peak flows more common with climate change.	Bathymetric surveys, hydraulic testing and other information necessary to design the cap to prevent unacceptable flood rise and protect the cap from erosion under higher flow conditions associated with climate change.
Caps will also factor in appropriate earthquake design elements for contingency level events.	Geotechnical testing to evaluate sediment bed stability and cap stability in the event of an earthquake.
If caps are required within the navigation channel and future maintenance dredge areas, work will be coordinated with USACE to ensure the cap is compatible with current and anticipated waterway use.	Bathymetric surveys and waterway use surveys to ensure the cap is compatible with current and anticipated waterway uses.
Any proposed capping in the navigation channel and future maintenance dredge areas will consider the current and authorized channel depth, the potential for an increase to the currently authorized channel depth, future navigation and maintenance dredging, and an appropriate buffer depth to ensure the integrity of the cap.	Bathymetric surveys and waterway use surveys to ensure the cap is compatible with current and anticipated waterway uses.

Table 5-2. Capping Design Requirements and Characterization

Design Requirement	Characterization Needed
Specific Cap Design Requirements	
PTW (NAPL/not reliably contained) – Significantly Augmented Cap: Cap design will include organoclay, other reactive material, and/or low permeability material, as necessary, to provide a sufficient chemical isolation layer to reliably contain underlying contamination.	Surface and subsurface sediment sampling to determine whether PTW (NAPL/not reliably contained) is present and support cap design, including the use of reactive and low permeable capping materials.
PTW (Highly Toxic) – Reactive Cap: Cap design may require the use of activated carbon and/or other reactive material, as necessary, to meet RAOs.	Surface and subsurface sediment sampling to determine whether PTW (highly toxic) is present and support cap design, including the use of reactive capping material.
Areas of Groundwater Contamination and/or Porewater Exceedance – Reactive Cap: Cap design will require the use of activated carbon, other reactive material, and/or low permeability materials, as necessary, to prevent contaminant migration through the cap, accounting for the degrees of upland source control.	Surface and subsurface sediment porewater sampling and estimation of groundwater flux to support cap design, including the use of reactive and low permeability capping materials.
Structures: Caps placed below or adjacent to structures will consider the logistics of placing capping material below structures and any physical constraints adjacent to the structure, including sediment bed slope, current and future navigation uses, and propeller wash. Minor structures, such as outfalls, will be moved to accommodate dredging and capping when necessary.	Survey of existing site structures, including an evaluation of condition, permanence and use of the structure. Geotechnical testing, as necessary, to design caps below and adjacent to site structures.
Debris: Cap design will consider the presence or absence of debris. Any debris that hinders expected cap performance will be removed prior to cap placement unless it can be demonstrated that the debris is infeasible to remove.	Debris survey (e.g., side-scan sonar survey) to identify the presence of debris, develop debris removal and management strategies, and evaluate the feasibility of debris removal.
Slope: Cap design will consider the slope of the sediment bed. Sediment caps will be designed to remain in place. This may require removal of material to lessen the slope angle or incorporation of buttresses at the base of the slope to maintain stability and promote establishing habitats.	Bathymetric surveys. Geotechnical testing to ensure sediment bed can support the cap. Collection of the waterway use and hydraulic data, as necessary, to support the hydrodynamic modeling required to design and construct erosion protection layers.
Flood Rise and Navigation: Caps will be designed to avoid adverse impacts to the floodway, consistent with the Executive Orders for Floodplain Management (Executive Orders 11988 and 13690) and FEMA regulations. Additionally, caps will be designed to avoid adverse impacts to current and future navigation based on expected cap thickness, authorized channel depth, and appropriate buffer. This may limit cap construction in some locations or require removal of contaminated sediment prior to cap placement.	Bathymetric surveys and collection of hydraulic data, as necessary, to support the hydrodynamic modeling required to evaluate the impact of the cap design on flood rise and flood storage.
Land and In-River Use: Caps will need to be designed consistent with anticipated uses so that the cap is not destroyed or damaged by those uses.	Land and waterway use surveys, as necessary, to support cap design, including impacts on navigation uses and determining the need for ICs necessary to protect the cap.
Additional Requirements: Additional requirements may be determined during remedial design and in coordination with NMFS and USFWS to comply with ARARs.	Additional surveys and testing, as necessary, to evaluate the effect of the cap on aquatic and riparian resources and to comply with ARARs.

Appendices

Appendix A

Remedial Design Frequently Asked Questions

Appendix A (April 2021 Version)

Remedial Design Frequently Asked Questions

This appendix provides a summary of U.S. Environmental Protection Agency (EPA) responses to frequently asked questions during remedial design for the Portland Harbor Superfund Site (Site). In general, the responses below were provided to the Participation and Common Interest (PCI) Group who presented the bulk of these questions in documents and during conference calls to EPA over the months of September and October 2018. EPA addressed these questions and provided a hardcopy summary of the questions and responses to the PCI Group members at an EPA-led meeting in Portland, Oregon on December 4, 2018. After this delivery, EPA made additional updates to the FAQ in December 2019 to clarify specific responses that were pertinent to the 2018 to 2019 baseline sampling results. To preserve the original content and responses within these FAQs and to remain consistent with EPA's ROD and baseline sampling record, EPA will no longer revise this appendix.

Question	EPA Response	ROD Excerpts and ROD Responsiveness Summary Reference(s)
Decision Tree Technology Selection and Flexibility		
Will the FS decision trees be used moving forward? Or were they superseded by the ROD decision tree (Figure 28)?	The ROD decision tree (ROD Appendix I, Figure 28) supersedes the FS decision trees.	ROD Sections 11 and 14, pages 85–87 and 103: A revised decision tree has been developed for the Selected Remedy that provides more clarity in how design data will influence design and construction (Figure 28 in Appendix I). ROD Section 14.2, pages 105–106: The final technology assignment will be identified in the remedial design, after collection of additional sampling data in all areas and segments of the river. The technology assignment will be identified as indicated in the decision tree in Figure 28 in Appendix I.
Where is the flexibility in the ROD decision tree to consider site-specific characteristics in assigning an appropriate technology?	Capping and/or dredging will be used in areas that exceed the RALs for the focused COCs or PTW thresholds (Appendix II, Table 21). The flexibilities related to capping and dredging design requirements are described in ROD Section 14.2.9. Site-specific conditions, such as but not limited to, navigation and land use information, whether structures are present, and what type of slope exists or may result from cleanup, will inform technology selection and remedial design in the SMAs.	ROD Section 11, pages 85–87: In response to comments on the Proposed Plan, EPA has revised, simplified, and clarified the decision tree (Figure 28 in Appendix I) to show how design data will be incorporated into remedial design decisions. In addition, the decision tree is accompanied by specific design requirements, presented in Section 14.2.9. ROD Section 14.2, pages 105–106: The final technology assignment will be identified in the remedial design, after collection of additional sampling data in all areas and segments of the river. The technology assignment will be identified as indicated in the decision tree in Figure 28, Appendix 1. In addition, reasonably anticipated future navigation and land use information and other data will be collected at a much greater level of detail than information collected as part of the RI to support the Remedial Design. When applying the decision tree logic with newly gathered information, the design and constructed remedy will reflect the newer information. After identifying appropriate cap or dredge technologies through this process, further modifications may be necessary during design to ensure the final constructed remedy is appropriate for actual Site conditions. ROD RS: Sections 2.8.4, 2.21.2, 3.1.53, and 4.1.7.
Remedial Action Areas		
If the SMAs outlined in the ROD will be revised based on newly collected data, where will remediation occur?	As specified in the ROD and ROD decision tree (Appendix I, Figure 28), capping and/or dredging will occur in SMAs, which are areas exceeding the RALs for the focused COCs or the PTW thresholds (Appendix II, Table 21) as determined with the PDI/BL data, the relevant RI/FS data, and through updated sampling and analysis during RD. ENR will occur in areas of Swan Island Lagoon not addressed by dredging or capping, unless those areas have recovered naturally. MNR will be used to achieve the final cleanup levels outside of actively remediated areas. See Section 1.4 of *Remedial Design Guidelines and Considerations* (RDGC) for additional discussion on historical data replacement strategies.	ROD Section 14.2, pages 104–105: Areas to be capped or dredged will be defined by RALs for the Selected Remedy (Table 21, in Appendix II). RALs are contaminant-specific sediment concentrations of focused COCs used to define areas of more active cleanup and will reduce contaminant concentrations and risks more effectively than ENR or MNR from current Site-wide average concentrations.
If newly collected data indicate that SMAs are different than those presented in the ROD, is an ESD required to complete RD/RA?	An ESD would not be necessary because the ROD anticipated that the horizontal and vertical extent of the SMAs (defined by RAL and PTW exceedances) would be refined based on the PDI/BL data and additional data collected during RD.	ROD Section 14.2.7, *Baseline and Remedial Design Data Collection*, page 111: Significant remedial design sampling to determine existing baseline levels of contamination and to design the cleanup will be conducted before construction begins. Baseline sampling will be done to identify existing conditions at the Site and will include a statistically valid data set for sediment, riverbanks, surface water, groundwater, porewater, and fish tissue samples. This will include a statistically valid number of samples and use of the 95% UCL for both surface and subsurface sediment concentrations in and near where contamination was identified in the RI/FS to determine SWAC(s) and for the purposes of applying the decision tree, as well as in proceeding with the design of active remediation throughout the Site. Data will be collected consistent with EPA-approved RI/FS decision rules on data collection (e.g., treatment of a nondetect value) and will be evaluated on spatial and temporal scales appropriate for the RAOs.
How many of the 1,774 acres that EPA is allowing to recover naturally are already below cleanup goals?	The 2018 Pre-RD Group PDI/BL data will provide an updated estimate of how many of the 1,774 acres designated for natural recovery are below ROD cleanup levels (Appendix II, Table 17). Future long-term monitoring data will be used to monitor the progress of the remedy toward achieving the RAOs established in the ROD.	ROD Section 14.2.7, *Long-Term Monitoring*, page 112: Data on contaminant levels will be used for multiple purposes, to determine if natural recovery is occurring as expected or if any additional actions are required to achieve the cleanup goals within the planned timeline. ROD RS: Sections 2.2.4, 2.10.1, 2.16.1, and 3.2.43.
Sequencing of Site Wide Remedial Design		
Do concerns regarding upstream to downstream migration of contaminants suggest that RD of downstream areas should occur after RD/RA of upstream areas?	Remedy sequencing will consider the potential for recontamination of remediated areas by upstream contamination or remedial activities. Areas most prone to potential recontamination are those with the highest degree of proximity and connectedness to unremediated areas or remedial actions. For example, contaminant migration is more likely to affect neighboring downstream areas and less likely to affect areas across the river channel or of significant distance away. Generally, when areas are in close, direct communication, sequencing will be done in an	ROD Section 14.2.11, page 116: Due to the size of the Site and the breadth of contamination, implementation of the Selected Remedy may need to be conducted in phases and/or work sequenced. To implement the remedy, EPA will consider, at a minimum, source control actions, recontamination potential, scope (size) of the actions across the Site, impacts to the river users and the community, seasonal weather impacts, fish windows, and implementation approaches the parties that agree to perform the cleanup may suggest. Sequencing of cleanup may consider factors such as potential impacts of upstream work on downstream areas, including but not limited to, the potential for resuspension of contaminants during construction,

	upstream to downstream manner and/or prioritizing areas with the heaviest contamination. However, concurrent Site-wide RD will not be substantially affected by concerns regarding the migration and redeposition of contaminated sediments as many SMAs are significant distances from each other or located off the main stem of the river (where resuspended contaminants are subject to less downstream flow).	nature and extent of contamination, and integration of the cleanup actions into the overall Site remedy.
Will areas of the Site exceeding RALs be able to delay RD until more contaminated upstream areas are successfully remediated?	EPA believes it is important for all areas to initiate the RD process and begin collecting the higher-density, site-specific remedial design data. While it is recognized that the dynamic character of the Willamette River may change surface sediment contaminant concentrations over time, it is less likely that the contamination at depth will change substantially. The completion of concurrent Site-wide RD will allow for effective sequencing of cap and dredge construction to minimize recontamination of these constructed areas.	See above response with excerpted text from ROD Section 14.2.11, page 116.
Will areas of the Site exceeding RALs be able to perform data gaps sampling to assess MNR without completing the full RD process?	As specified in the ROD and ROD decision tree (Appendix I, Figure 28), capping and/or dredging will occur in all areas exceeding RALs or PTW thresholds (Appendix II, Table 21). Generally, EPA expects these areas within the Site will need to undergo the full RD process. Natural recovery of surface sediment COCs will be monitored in the future by replicating the 2018 nonbiased sediment sampling program.	ROD Section 14.2, pages 104–105: Areas to be capped or dredged will be defined by RALs for the Selected Remedy (Table 21, in Appendix II). RALs are contaminant-specific sediment concentrations of focused COCs used to define areas for more active cleanup and will reduce contaminant concentrations and risks more effectively than ENR or MNR from current Site-wide average concentrations.
Remedial Design Investigations		
Will the 2018 Pre-RD Group PDI/BL data be considered during RD?	The 2018 Pre-RD Group PDI/BL data will be considered in RD and should be used to inform additional site-specific data collection needs during the full remedial design process.	ROD Section 14.2.7, *Baseline and Remedial Design Data Collection*, page 111: Significant remedial design sampling to determine existing baseline levels of contamination and to design the cleanup will be conducted before construction begins. Baseline sampling will be done to identify existing conditions at the Site and will include a statistically valid data set for sediment, river banks, surface water, groundwater, porewater, and fish tissue samples. This will include a statistically valid number of samples and use of the 95% UCL for both surface and subsurface sediment concentrations in and near where contamination was identified in the RI/FS to determine SWAC(s), and for the purposes of applying the decision tree, as well as in proceeding with the design of active remediation throughout the Site. Data will be collected consistent with EPA-approved RI/FS decision rules on data collection (e.g., treatment of a nondetect value) and will be evaluated on spatial and temporal scales appropriate for the RAOs.
Will additional characterization be needed beyond the 2018 Pre-RD Group sampling?	Data needs in any given area are a site-specific determination. For example, areas may need higher resolution sampling of the horizontal and vertical extent of contamination, and additional information on current and anticipated future land/waterway use, structures, habitat, and flood storage.	See above response with excerpted text from ROD Section 14.2.7, Baseline and Remedial Design Data Collection, page 111.
How will RD incorporate the source control status of an adjacent upland property?	EPA is working with Oregon DEQ to ensure that issues with source control are addressed prior to and during the RD process. During design, EPA will require a source control sufficiency assessment to evaluate whether potential sources of recontamination have been adequately investigated and controlled or considered such that the remedial action can proceed. The sufficiency assessment will include an upland evaluation of pathways to the river through direct discharges, groundwater, river bank, and overwater to ensure that upland sources have been controlled. The assessment will also evaluate potential in-water sources of recontamination including the resuspension of bedded sediments.	ROD Section 9, page 55: It is EPA's expectations that DEQ's actions to address upland source control will adequately address contaminated soils, surface water, and especially groundwater contamination migrating to the river consistent with CERCLA. Response actions will address contamination within the in-river portion of the Site and associated river banks. There are known sources of contamination in the upland areas and known sources in locations in the downtown reach of the river (approximately RM 12 to RM 16.6). EPA is relying on the Oregon DEQ to use its authorities to address these sources. It is expected that controlling these sources will reduce or eliminate contamination in soil, groundwater, stormwater, and surface water that migrates to the Willamette River.
Horizontal and Vertical Delineation of SMAs During Remedial Design		
The first decision box on Figure 28: Technology Application Decision Tree requires a determination of whether one is "Within SMA (See Note 1)". Note 1 states "Contamination is defined in three dimensions." In this context, what does it mean that contamination is defined in three dimensions?	The extent of sediment concentrations exceeding RALs for the ROD focused COCs must be defined laterally and vertically throughout the area of contamination. This three-dimensional information is used to define the extent of the SMAs and for application of the decision tree to guide the assignment of capping and dredging technologies. The PDI/BL data, along with future RD data and the relevant RI/FS data, will be used to define the lateral and vertical extent of contamination during design. Data gaps on the lateral and vertical extent of contamination will be addressed during site-specific design investigations.	See above response with excerpted text from ROD Section 14.2.7, Baseline and Remedial Design Data Collection, page 111.
How will the vertical extent of contamination be determined?	The vertical extent of contamination will be determined by collecting subsurface sediment cores and sampling them in 1-foot intervals. Previously collected data and the conceptual site model will be used to determine the depth of sediment cores required. The 1-foot intervals will allow for finer resolution of the contamination that is present, which will reduce the uncertainty of the vertical extent of COCs above RALs, improving technology selection and design. The PDI/BL data contained 90 subsurface sediment cores in the SMAs that will be used during RD to inform the vertical extent of contamination.	ROD Section 14.2.9.2, page 114: Dredging designs will consider the lateral and vertical extent of contamination. The lateral extent of contamination will be based on the SMAs (RALs and PTW; see Section 14.2.7, Monitoring Requirements). The vertical extent of contamination will be based on the decision tree in Figure 28 in Appendix I.
If surface sediment concentrations are below RALs, but there are RAL exceedances at depth, is one within an SMA or not?	Whether an area is within an SMA is dependent on the depth of RAL exceedances. Site-specific conditions based on the PDI/BL data and additional data collected during RD will be considered to refine dredging and cap design. For a protective cleanup, this determination must consider the long-term potential for exposure to	See above response with excerpted text from ROD Section 14.2.7, Baseline and Remedial Design Data Collection, page 111. ROD RS: Sections 2.1.2, 2.13.2, 3.1.68, and 4.1.13.

	subsurface sediment contamination. See Section 1.4 of RDGC for additional discussion on buried contamination.	
Is there a minimum depth of sediment with concentrations below RALs which would make exceedances at depth irrelevant? For example, if there are two feet of clean sediment over sediment exceeding RALs, is dredging still prescribed? Five feet?	Site-specific information from the PDI/BL data, the relevant RI/FS data, and additional information developed during RD will be required to determine whether it is reasonable to anticipate that contamination at depth will not be exposed in the future and therefore can be left in place.	ROD Section 14.2.9.2, page 114: Dredging designs will consider the lateral and vertical extent of contamination. The lateral extent of contamination will be based on the SMAs (RALs and PTW; see Section 14.2.7, Monitoring Requirements). The vertical extent of contamination will be based on the decision tree in Figure 28 in Appendix I.
Remedial Design Issues		
Dredging may generate slope failure. Do the design requirements in Section 14.2.9 allow for consideration of the slope of the sediment bed in dredging design?	Slope stability analyses will need to be performed to address these site-specific conditions.	ROD Section 14.2.9.1, page 114: Cap design will consider the slope of the sediment bed. Sediment caps will be designed to remain in place. This may require removal of material [i.e., dredging] to lessen the slope angle or incorporation of buttresses at the base of the slope to maintain stability and promote establishing habitats. ROD RS: Sections 2.21.3, 3.1.53, and 3.1.71.
Do the design requirements in Section 14.2.9 allow for consideration of whether an area is depositional in assigning an appropriate technology? Will deposition be considered in RD?	As specified in the ROD and ROD decision tree (Appendix I, Figure 28), capping and/or dredging will occur in all areas exceeding RALs or PTW thresholds (Appendix II, Table 21). However, sediment deposition as well as but not limited to impacts from propwash scour, extreme flood events, wind- and vessel-generated waves, etc. will be considered during RD. These data will inform cap design and future cap monitoring.	ROD Section 14.2, *Post-ROD Data Gathering and Other Information Verification*, page 106: For purposes of the FS, several assumptions were made about what the Selected Remedy would look like in the river after applying the decision tree based on existing data. Post-ROD sampling will be conducted to support remedial design and to refine the CSM. This updated information will be used for design/construction. Post-ROD sampling will include, in addition to other relevant data, surface and subsurface sediment contaminant concentrations, surface water, sediment porewater and groundwater data, bathymetry, flood-rise modeling, fish/shellfish tissue, and NAPL delineation.
Do the design requirements in Section 14.2.9 allow for consideration of the presence of rock/cobble/bedrock in assigning an appropriate technology? Will the presence of hard substrate bottoms be considered in RD?	Physical characteristics of the sediment bed, including the presence of rock/cobble/bedrock, will be considered in technology selection and RD.	See above response with excerpted text from ROD Section 14.2, *Post-ROD Data Gathering and Other Information Verification*, page 106.
Do the design requirements in Section 14.2.9 allow for consideration of the impact of dredging on habitat areas?	As stated in ROD Section 14.2.9.1, additional requirements may be determined during RD and in coordination with NMFS and USFWS to comply with ARARs.	ROD Section 14.2.9.1, page 113: In habitat areas, currently defined by NMFS as those areas above -15 feet CRD, post-remedy surfaces will be maintained at their current depth and backfilled or capped with suitable habitat materials. ROD Section 14.2.9.2, *General Dredging, Residuals Management*, page 114: In the shallow region, residual management will consist of capping or backfilling to grade to prevent exposure above cleanup levels and to minimize adverse effects on in-river and riparian habitat, including the loss of shallow water habitat. ROD Section 14.2.9.2, *Water Quality Controls*, page 115: Water quality controls, including silt curtains and/or rigid containment (e.g., sheet pile wall enclosures) may be required to minimize releases to the water column associated with the presence of contaminated sediments, NAPL, debris, and other chemical or physical conditions to comply with water quality standards. Additional requirements may be determined during remedial design and in coordination with NMFS and USFWS to comply with ARARs. ROD Section 15.2.3, page 129: The Selected Remedy will be designed to avoid or minimize adverse impacts to aquatic resources and waters of the United States. ROD RS: Sections 2.8 (and subsections) and 2.13.1 provide clarifications on habitat questions.
The definition of structures in Figure 28 does not appear to be very flexible and is not particularly consistent with dock ownership and uses at various properties. How are such site-specific uses to be addressed given the ROD Figure 28 decision tree's lack of recognition of such issues?	Additional factors regarding site structures may be considered in the RD information, as appropriate. Current and future land uses, ownership, flood storage/rise, habitat creation, and the vertical extent of contamination all need to be considered in the RD.	ROD Figure 28 and Section 14.2, *Post-ROD Data Gathering and Other Information Verification*, page 106: In addition, reasonably anticipated future navigation and land use information and other data will be collected at a much greater level of detail than information collected as part of the RI to support the Remedial Design. As part of the FS, observed current uses were assumed to continue in the river. During the public comment period, some parties identified that the potential future use(s) of a part of the river may be other than current uses or EPA's assumptions. To ensure that the correct reasonably anticipated future uses are used for the remedial design, these assumptions will be verified and will be altered, as appropriate. For example, eliminating the need for a more expensive dredge and armored cap remedy if a significant area will no longer to be used for marine terminal purposes.
Capping Without Dredging		
Under what scenario would capping without pre-dredging be allowed in the intermediate depth region?	Current and future land uses, flood storage/rise, habitat creation, slope stability, and the vertical extent of contamination all need to be considered to determine whether capping without pre-dredging will be allowed in the intermediate depth region.	ROD Section 14.2, *Post-ROD Data Gathering and Other Information Verification,* page 106: During the public comment period, some parties identified that the potential future use(s) of a part of the river may be other than current uses or EPA's assumptions. To ensure that the correct reasonably anticipated future uses are used for the remedial design, these assumptions will be altered, as appropriate. For example, eliminating the need for a more expensive dredge and armored cap remedy if a significant area will no longer be used for marine terminal purposes. ROD Section 14.2.9.1, Flood Rise and Navigation, page 114: Caps will be designed to avoid adverse impacts to the floodway, consistent with the Executive Orders for Floodplain Management (Executive Orders 11988 and 13690) and FEMA regulations. Additionally, caps will be designed to avoid adverse impacts to current and future navigation based on expected cap thickness, authorized channel depth, and appropriate buffer. This may limit cap construction in some locations or require removal of contaminated sediment prior to cap placement.
ROD Section 14.2.3 states that, "the elevation of the top of the cap or residual layer will be no higher than the pre-design elevation" which appears to	It is not EPA's intent to limit shallow water habitat; however, avoiding or minimizing impacts to the floodway need to be considered in conjunction with habitat creation. Furthermore, site-specific cap designs will require review by NMFS, USFWS,	ROD Section 14.2.3, page 108: Under any scenario, the elevation of the top of the cap or residual layer will be no higher than the pre-design elevation to avoid loss of submerged aquatic habitat, preserve slope stability, and

preclude the option of increasing the valuable shallow water habitat as part of remedial action. Is that EPA's intent?	and others and may be modified to improve aquatic habitat.	negate adverse impacts to the floodway. If appropriate to protect sensitive species, a habitat layer will be incorporated into the constructed remedy. ROD RS: Sections 2.8 (and subsections) and 2.13.1 for clarifications on habitat questions.
Alternative/Other Remedial Technologies		
Why are alternative/other remedial technologies, such as in situ treatment and ENR, not included for potential use within SMAs on the Technology Application Decision Tree (Figure 28)?	Capping and dredging were determined during the FS to achieve the greatest and most permanent risk reductions for the most contaminated sediments, which are in SMAs. Therefore, the use of alternative remedial technologies can only be applied in areas below RALs and PTW thresholds.	ROD Section 14.1, page 103: The Selected Remedy is protective of human health, complies with ARARs, and provides the best balance of tradeoffs among the balancing criteria, including addressing many of the Tribal community's concerns as well as community concerns raised through public comments. It reduces risk within a reasonable time frame, is practicable, provides for long-term reliability of the remedy, and minimizes reliance on institutional controls. It will achieve substantial risk reduction by dredging and capping areas with the most contaminated sediments, reduce remaining risks to the extent practicable through ENR and MNR, and manage remaining risks to human health through institutional controls.
If supported by available data, will EPA accept alternate technologies specified in the ROD design requirements for areas exceeding RALs but below PTW thresholds? If there is a lot of deposition, can one make the demonstration that partial dredge and cap, ENR, or MNR is appropriate for an area exceeding RALs – would this be acceptable?	As specified in the ROD and ROD decision tree (Appendix I, Figure 28), capping and/or dredging will occur in all areas exceeding RALs or PTW thresholds (Appendix II, Table 21). However, alternate technologies such as in situ treatment and ENR may be considered for use in areas below RALs on a site-specific basis.	ROD Section 14.2, pages 104–105: Areas to be capped or dredged will be defined by RALs for the Selected Remedy (Table 21, in Appendix II). RALs are contaminant-specific sediment concentrations of focused COCs used to define areas of more active cleanup and will reduce contaminant concentrations and risks more effectively than ENR or MNR from current Site-wide average concentrations. ROD RS: Sections 3.1.3, 3.1.33, 3.1.66, 3.1.67, 3.2.2, 3.2.5, 3.5.2 for clarifications on ENR and MNR application.
River Banks		
How is the top of bank defined (elevation, abrupt change in slope angle, other)?	Defining the top of the bank is site-specific and is visually determined based on the angle of the slope towards the river. Additional guidance will be provided in a river bank guidance document that EPA is developing.	ROD Section 14.2.5, page 109: River banks are defined as areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas. Remediation of contaminated river banks is included in the Selected Remedy where it is determined that it should be conducted in conjunction with the in-river actions and to protect the remedy (Figure 9 in Appendix I and Table 21 in Appendix II). Other river banks may be included in the remedial action if contamination contiguous with contaminated river sediment is found during remedial design sampling. ROD Section 14.2.9.5, page 116: In an SMA, contaminated river banks will be remediated through this cleanup where they are contiguous with in-river contamination or where they pose a risk of recontamination to the Selected Remedy. ROD: Sections 14.4, 15.1.3, 15.2.3 detail additional riverbank requirements for the Selected Remedy. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Does the ROD allow flexibility for river bank capping with materials other than vegetation with beach mix?	Selection of river bank cap materials will be based on site-specific considerations addressed under design. River bank source control and containment to meet the RAOs will be considered on a site-specific basis during RD.	ROD Section 14.2.5, page 109: Engineered caps or vegetation with beach mix will be placed as the final cover based on area-specific designs, which will account for appropriate slope according to the programmatic or site-specific Biological Opinion, as appropriate. See above response with excerpted text from the following: • ROD Section 14.2.7, *Baseline and Remedial Design Data Collection*, page 111 • ROD Section 14.2.9.5, page 116 ROD: Sections 14.4, 15.1.3, 15.2.3 detail additional river bank requirements for the Selected Remedy. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Does the ROD allow for flexibility to consider the net benefit to overall habitat and function resulting from combined river bank remediation and shallow region in-water remediation? For example, would EPA consider relaxing the shallow region requirement that "the elevation of the top of the cap or residual layer will be no higher than the pre-design elevation" if concurrent riverbank remediation would result in a net benefit to habitat?	The question is hypothetical and needs to be supported by site-specific design data. Habitat elements of the design will be determined in coordination with NMFS, USFWS, and others. Based on site-specific factors, it may not be possible to obtain the optimal river bank. However, it might be possible to fill in some areas without affecting the floodway. Primary concerns include not affecting or mitigating impacts to the floodway due to habitat creation.	ROD Section 14.2.9.5, page 116: In an SMA, contaminated river banks will be remediated through this cleanup where they are contiguous with in-river contamination or where they pose a risk of recontamination to the selected remedy. These cleanups will be conducted in a manner that is compatible with the Selected Remedy and minimizes adverse impacts to riparian habitat including minimizing slope angle and the use of hardened banks to prevent erosion. ROD: Section 14.4, page 118: Implementation of the Selected Remedy will result in improvements in the overall river habitat, with positive impacts on all species that use the river, including freshwater rearing sites and migration corridors that are essential to the conservation of the listed salmonid species and species that have a role in tribal lifestyles. ROD: Section 15.2.3, page 128: In addition, avoidances and minimization measures would be implemented on Site to restore substrate, slope, and natural cover to the extent possible to maintain habitats and functions that would be altered during implementation. Compensatory mitigation would be required to replace lost habitats and functions such that there would be no net loss of aquatic resource functions. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Is river bank remediation required throughout all riverbank areas shown on Figure 9?	The need for river bank remediation will depend on design sampling data and site-specific conditions (e.g., nature of the bank, land and waterway use). Additional guidance will be provided in a river bank guidance document that EPA is developing.	ROD Section 14.2, *Post-ROD Data Gathering and Other Information Verification*, page 106: Post-ROD sampling will be conducted to support remedial design and to refine the CSM. This updated information will be used for design/construction. Post-ROD sampling will include, in addition to other relevant data, surface and subsurface sediment contaminant concentrations, surface water, sediment porewater and groundwater data, bathymetry, flood-rise modeling, fish/shellfish tissue, and NAPL delineation. See above response with excerpted text from the following: • ROD Section 14.2.7, Baseline and Remedial Design Data Collection, page 111

		• ROD Section 14.2.9.5, page 116 ROD: Sections 14.4, 15.1.3, 15.2.3 detail additional river bank requirements for the Selected Remedy. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Would river bank remediation be required if source control measures such as erosion and stormwater control are in place?	This is a hypothetical question that depends on what is developed and presented in the design package for a specific area. The status of source control measures to address bank erosion and stormwater discharges relative to the RAOs will be considered during design. During design, EPA will require a source control sufficiency assessment to evaluate whether potential sources of recontamination have been adequately investigated and controlled or considered such that the remedial action can proceed.	See above response with excerpted text from the following: • ROD Section 14.2.7, *Baseline and Remedial Design Data Collection*, page 111 • ROD Section 14.2.9.5, page 116 ROD: Sections 14.4, 15.1.3, and 15.2.3 detail additional riverbank requirements for the selected remedy. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Can additional sampling and analysis (e.g., chemical testing, slope stability, etc.) be performed to modify the areas targeted for river bank remediation on ROD Figure 9?	Additional sampling and analysis are a component of design and would provide information as part of an overall design package that could possibly modify the area targeted for remediation on ROD Figure 9. Additional guidance will be provided in a river bank guidance document that EPA is developing.	See above response with excerpted text from the following: • ROD Section 14.2.7, *Baseline and Remedial Design Data Collection*, page 111 • ROD Section 14.2.9.5, page 116 ROD: Sections 14.4, 15.1.3, 15.2.3 detail additional river bank requirements for the Selected Remedy. ROD RS: Sections 2.26.2, 3.1.15, and 4.2.10.
Remedial Design Administrative Structure		
Is RD directly coupled with RA through a consent agreement with EPA?	Under the Superfund statute, when parties perform RA, it must be done under a judicial consent decree or unilateral administrative order. RD can be done under one of these mechanisms, or under an administrative settlement and order on consent. Generally, EPA likes to combine RD and RA under a consent decree.	Information on this topic is not covered in the ROD or ROD RS.
What is the agreement/consent structure that EPA is seeking to perform RD?	EPA has agreed to postpone issuance of special notice letters to initiate Consent Decree negotiations to allow for completion of the allocation process. However, in the interim, EPA is looking for RD to move forward Site-wide through administrative settlements. Currently, RD is occurring under administrative settlements and orders on consent at the GASCO, River Mile 11E, and Port of Portland Terminal 4 Project Areas. EPA would like to be moving RD forward on all the SMA areas.	Information on this topic is not covered in the ROD or ROD RS.

Notes:

ARAR – applicable or relevant and appropriate requirements
COC – contaminant of concern
CRD – Columbia River datum
CSM – conceptual site model
DEQ – Oregon Department of Environmental Quality
ENR – enhanced natural recovery
EPA – United States Environmental Protection Agency
ESD – Explanation of Significant Differences
FS – feasibility study
MNR – monitored natural recovery
NAPL – nonaqueous phase liquid
NMFS – National Marine Fisheries Service
ODFW – Oregon Department of Fish and Wildlife
PDI/BL – pre-remedial design investigation and baseline sampling
PRP – potentially responsible party
PTW – principal threat waste
RA – remedial action
RAL – remedial action level
RAO – remedial action objective
RD – remedial design
RI – remedial investigation
RM – river mile
ROD – Portland Harbor Superfund Site Record of Decision
RS – responsiveness summary
Site – Portland Harbor Superfund Site
SMA – sediment management area
SOW – statement of work
SWAC – surface-area-weighted average concentration
UCL – upper confidence limit
USFWS – United States Fish and Wildlife Service

Appendix B

Remedial Design Topics and Discussion

Appendix B (April 2021 Version)

Remedial Design Topics and Discussion

This appendix provides additional information on remedial design topics not fully addressed in the U.S. Environmental Protection Agency (EPA) document *Remedial Design Guidelines and Considerations* (RDGC). These topics are briefly described in the table below and discussed in more detail on subsequent pages. The purpose of this appendix is to provide a record of specific topics related to remedial design that will inform all parties conducting design activities throughout the Portland Harbor Superfund Site (PHSS or Site). EPA understands some topics and the summary information may require modification for applicability to a specific remedial design effort within the Site. The information found within this appendix provides performing parties (PPs) with EPA-approved concepts and approaches to key remedial design elements that, at a minimum, provide a framework for continuity, consistency, and efficiency in performing remedial design throughout the Site. Considering Site remedial design efforts have just started, this appendix is considered a living document that will be updated by EPA as new topics are identified and worked through with PPs. An updated version of this appendix will be distributed periodically with a new version number and date as new topics are identified.

No.	Related RDGC Section	Topic and Description	Discussion
1	2.4	Methods for estimating total polychlorinated biphenyl (PCB) concentrations – PPs may propose different analytical methods for estimating PCB concentrations in media across the Site	Methods for estimating total PCB concentrations for each media need to meet the applicable data quality objectives (DQOs) and intended data uses. PCB congeners analysis is required for fish tissue, surface water, elutriate tests, and porewater to meet target cleanup levels (CULs). PCB congeners analysis is preferred for sediment and sediment trap sample analysis because the multiple sources of PCBs and varying degrees of weathering at the Site may hinder accurate quantification of PCBs and source identification when analyzing sediment using PCB Aroclor methods. However, PCB Aroclor analysis data are acceptable if reporting limits are below 9 micrograms per kilogram (µg/kg) (PHSS Record of Decision [ROD] CUL), otherwise PCB congener analysis is required.
2	5.2.5	Sediment cap modeling limitations – PPs may use different models for cap designs, and limitations for each should be considered	The use of CapSim or other cap models to predict cap performance is allowed by EPA but the guidelines and limitations of the models should be evaluated prior to using any model. All input parameters and equations need to be presented and transparent. No cap model should be used indiscriminately, and assumptions, limitations, and any deviations from guidance must be appropriately documented.
3	Not Applicable (NA)	Post-dredge cover and verification approach	Placement of residual management layers as soon as practicable following dredging will require accurate delineation of the depth of contamination (DOC), rapid verification that contamination exceeding remedial action levels (RALs) and principal threat waste (PTW) thresholds has been removed, and evaluation of the generated residuals to determine the thickness and composition of the residual management layer prior to placement.

No.	Related RDGC Section	Topic and Description	Discussion
4	5.1.2	Defining DOC during sediment management area (SMA) delineation and characterization needs for long-term stability of impacted sediment at depth – requirements for delineating DOC in areas outside ROD SMAs and guidelines for cases where contamination above RALs or PTW thresholds can be left in place are discussed	Vertical delineation of contamination is required for sites with nonaqueous-phase liquid (NAPL) or PTW that cannot be reliably contained, or areas where dredging is the assigned technology. At sites where NAPL or PTW that cannot be reliably contained do not exist and/or the sampling location is not within a dredging area, sediments with concentrations exceeding RALs or PTW thresholds at depth may be capped or left in place if it can be demonstrated that the subsurface sediments will remain stable and not pose unacceptable risk to human health or the environment.
5	5.1.2	Core sampling intervals – PPs may sample 1-foot core intervals in dredging areas, but 1-foot sampling intervals are not required in capping areas	Subsurface cores will be sampled in 1-foot intervals in dredging areas within an SMA. Based on site-specific parameters, PPs may propose a systematic approach for prioritizing chemical analyses to address concerns regarding sample volumes. Core sampling intervals greater than 1 foot may be used in capping areas within an SMA.
6	5.1.2	Understructure data collection during SMA delineation	SMA delineation under structures (e.g., piers, docks) should include obtaining surface and subsurface sediment samples for chemical analysis and not be limited to diver probing to estimate sediment depth.
7	NA	Remnant piling removal in remedial designs	Where feasible, removal of remnant piles is required in areas of contaminated sediment to enable access for future remedial activities and reduce potentially contaminated preferential habitat for aquatic receptors.
8	NA	404 permitting integration with institutional control implementation and assurance plans (ICIAPs)	The approach for integrating institutional controls (ICs) into the 404 permitting process is currently under development and will be described in an appendix to the programmatic ICIAP.
9	5.2.14	Habitat mitigation	The details of any necessary compensatory mitigation are to be developed during SMA-specific remedial design. Compensatory mitigation likely will involve the restoration, enhancement, establishment, and/or preservation of wetlands, streams, or other aquatic resources conducted specifically for the purpose of offsetting authorized impacts to aquatic resources on-site wherever possible.
10	1.4	Data replacement	Data replacement for surface sediment samples may be considered in cases where contaminant concentrations have changed substantively over time and spatial resolution is maintained or improved. PPs in remedial design may develop their own site-specific data replacement strategy, as approved by EPA, and the strategy must meet reasonable standards and considerations.
11	NA	Contaminant of concern (COC) requirements	These guidelines are intended to provide direction on the appropriate application of ROD Tables 17 and 21 during remedial design. As specified in the ROD, capping and/or dredging will occur in SMAs, which are areas exceeding RALs or PTW thresholds. Table 17 CULs are the long-term contaminant concentrations that need to be achieved to meet remedial action objectives (RAOs).

1. Methods for Estimating Total PCB Concentrations

1.1 Topic

PPs may propose methods for estimating total PCB concentrations that may not meet the established DQOs or are not consistent across the Site.

1.2 Portland Harbor Project Area Where Topic Was Identified

Wheeler Bay at Terminal 4

1.3 Discussion and Basis for Decision

The preferred means of estimating total PCB concentrations is to sum concentrations of individual congeners using a high-resolution methodology (e.g., EPA Method 1668). However, PCB Aroclor analysis (most commonly by EPA Method 8082) was used extensively during the Portland Harbor remedial investigation (RI)/feasibility study (FS) and may be acceptable in some instances. The congener method is less affected by "weathering," non-PCB interferences, uncertainties associated with mixing of PCB sources, and subjective Aroclor identifications. However, both methods can accurately estimate PCB concentrations in environmental media. For all chemical analyses, detection limits must be sufficient for the purpose of the evaluation (i.e., to meet RALs, PTW thresholds, or CULs). Further discussion of PCB analytical methods used during the Portland Harbor RI/FS is provided in Appendix D1.4 of the RI report (EPA 2016). High-resolution PCB congener analysis was the preferred method for fish tissue, surface water, and porewater/groundwater during the RI/FS and is required to meet ROD-specified CULs and target tissue levels for these media.

For sediment sample analysis, PCB congeners analysis is preferred, but PCB Aroclor analysis (e.g., EPA Method 8082A) may be used to estimate total PCB concentrations in sediment if all the following apply:

- DQOs will be met using PCB Aroclor data
- PCB Aroclor data will be suitable for the intended data uses
- The reporting limit for each Aroclor is less than 9 µg/kg (PHSS ROD CUL)
- There is a low potential for interferences with other chemicals (e.g., chlorinated pesticides) that may increase reporting limits above 9 µg/kg

PP quality assurance project plans must include archiving and confirmation analyses of held samples if the results for PCBs by Method 8082A are unable to achieve the 9 µg/kg reporting limit. Confirmation analyses on these held samples will use a high-resolution methodology for congeners (e.g., EPA method 1668).

The basis for this decision is that measured total PCB concentrations in sediment samples are fairly comparable between methods especially when measurement error is considered, as presented in Appendix D1.4 of the RI report (EPA 2016). The analysis of sediment data collected during the RI indicated that total Aroclor data overpredict total PCB congeners in concentrations below approximately 750 µg/kg total Aroclors, which should result in similar or more conservative site management decisions. The correlation between total PCB Aroclor and total PCB congener data based on over 360 Site surface and subsurface sediment samples that were analyzed using both methods is shown in Attachment 1A.

This graph demonstrates that the PCB congener and Aroclor methods are well correlated and generally produce similar concentration results.

1.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

None identified

1.5 Decision

High-resolution congener analysis is required to meet ROD-specific CULs and target tissue levels for fish tissue, surface water, and porewater/groundwater. High-resolution congener analysis (EPA Method 1668) for sediment samples is preferred, but PCB Aroclor analysis (EPA Method 8082A) may be used to estimate total PCB concentrations in sediment if this method will meet DQOs and intended data uses, and the reporting limit for each Aroclor is less than 9 µg/kg. If there is the potential for interferences with other chemicals (e.g., chlorinated pesticides) that may increase reporting limits, PCB congener analysis is required.

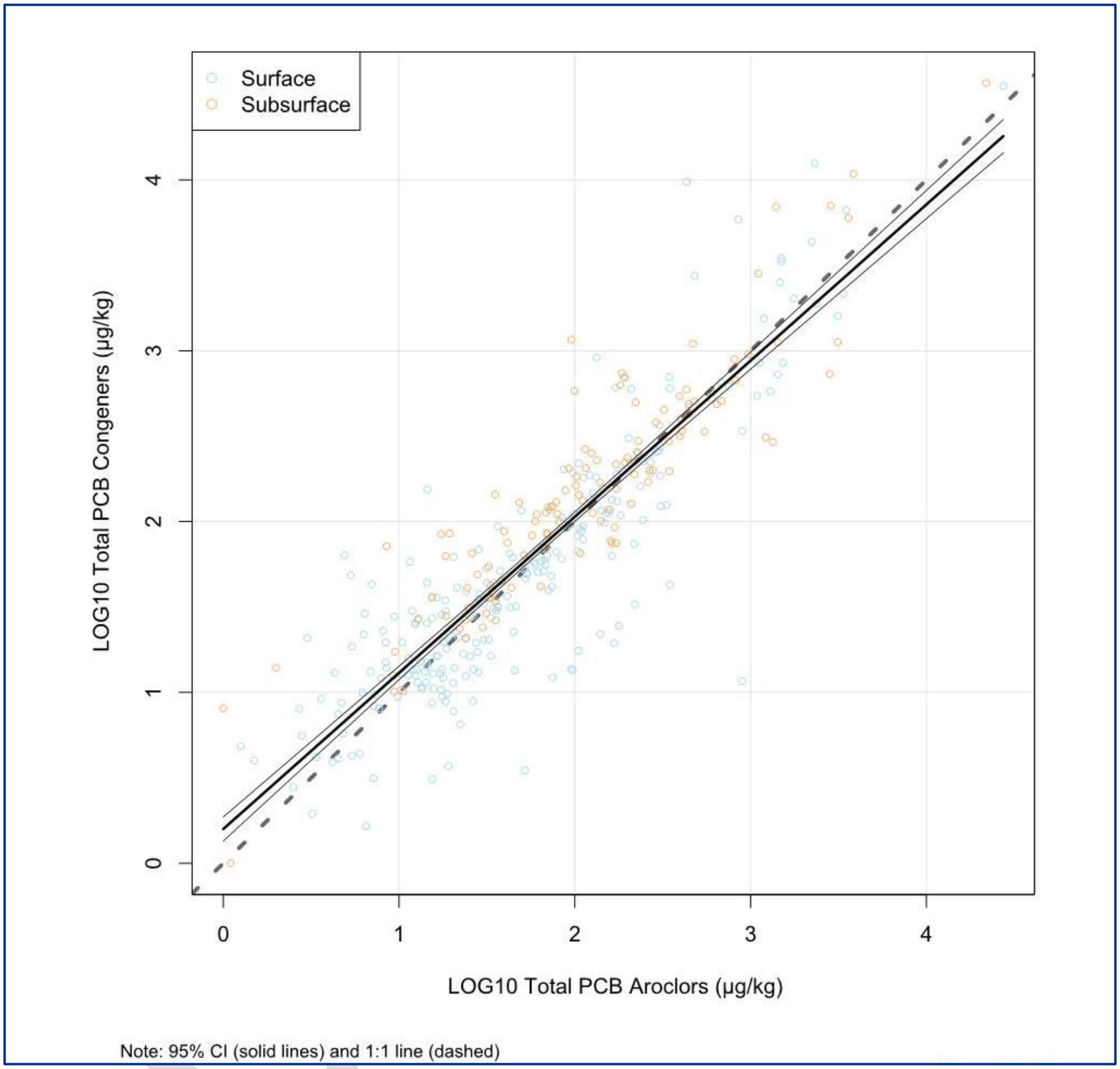
1.6 References

EPA. 2016. *Portland Harbor RI/FS, Final Remedial Investigation Report*, Appendix D1.4, Comparison and Use of PCB Aroclor and Congener Data. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

Attachments

Attachment 1A – Correlation of Total PCB Congeners and Total PCB Aroclor Analysis in Portland Harbor Surface Sediment Samples; Figure D1.4-3 from EPA 2016.

Attachment 1A: Correlation of Total PCBs as Congeners and Total PCBs as Aroclors in Portland Harbor Surface Sediment Samples



Source: Figure D1.4-3 from EPA 2016

2. Sediment Cap Modeling Limitations

2.1 Topic

As with any chemical fate and transport modeling, projections of contaminant migration through sediment caps are subject to the site's characteristics, the quantity and quality of relevant available information, and the approach and/or equations used to estimate the contaminant transport. Inherent uncertainty will always exist in these estimates (to varying degrees) and must be acknowledged during decision-making. Furthermore, remedial decisions based on sediment cap modeling should also acknowledge that analytical and mathematical models are representations of systems and often do not have the spatial resolution necessary to represent all small-scale heterogeneities or simulate all relevant processes with 100 percent (%) accuracy. These models provide estimates of what can occur within a system and not necessarily what will occur within a system. While the PPs may use different models/modeling applications to evaluate cap design, they should only do so with due consideration of the limitations of their understanding of the system, data quality and quantity, and selected model capabilities and limitations.

2.2 Portland Harbor Project Area Where Identified

NW Natural Gasco Sediments Site

2.3 Discussion and Basis for Decision

Sediment cap models can be used to estimate the effectiveness of remedial design caps. However, the limitations of a model and the inherent uncertainty in its estimates must be acknowledged. Some general guidelines for cap modeling are as follows:

- Cap models often require chemical-specific properties to be provided as input (e.g., molecular weight, n-octanol/water partition coefficient [K_{ow}], diffusivity in water). EPA recommends using the chemical-specific properties provided on the EPA website (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017) for model inputs. However, it is acceptable to use other reputable sources for these chemical properties, provided the source is appropriately documented.

- A range of observed or expected site conditions should be evaluated in any cap model to develop a better understanding of chemical fate and transport under multiple conditions. Typical cap model inputs for which a range of values should be evaluated include site-specific seepage rates, porewater concentrations, and fraction of organic carbon in sediments. When multiple chemicals are of concern at a site, model runs should also evaluate multiple chemicals of varying mobilities. For example, for a site were multiple polycyclic aromatic hydrocarbons (PAHs) are of concern, model simulations should use both a relatively high K_{ow} PAH and a relatively low K_{ow} PAH to help "bracket" estimates of contaminant breakthrough.

- Model assumptions should be identified and evaluated based on site conditions to confirm the assumptions depict actual mechanisms for the site. For example, if a model does not consider sedimentation, then that should be evaluated relative to site-specific conditions.

- Model inputs should be as representative of current site conditions as possible and should be clearly documented.
- A sampling program should be developed and implemented to confirm caps are performing as expected. The sampling program should have adequate areal spatial coverage across the cap, evaluate areas that may be subject to increased contaminant transport (e.g., cap edges, areas of increased seepage velocities, higher underlying contaminant concentrations), and collect data on the vertical gradient of porewater concentrations from the underlying sediment bed up to the cap surface. A robust baseline data set should be collected soon after cap installation so cap performance can be evaluated during subsequent sampling events.

Some PPs have chosen to use the CapSim model, developed by Dr. Danny Reible at Texas Tech University, for remedial design evaluations. Limitations specific to this model include the following:

- All fate and transport equations are not openly presented in the model or its supporting *Quick Start Manual*. Consequently, it is difficult to determine how the relevant equations are representing the various processes at the site. For example, the calculation used to determine benthic mass transfer coefficient is not presented. Therefore, it would be difficult for a user or reviewer to determine how accurately the model mass transfer coefficient in CapSim represents the various transport processes in the biologically active zone.
- CapSim has limitations in the surface processes, and it does not specifically address erosion, resuspension, and recontamination. The model applies an uncalibrated mass transfer coefficient to address surface conditions that would be best applied to predict concentrations at the bottom of the biologically active zone and not at the surface or within the biologically active zone. The sensitivity to surface processes should be evaluated along with other inputs.
- Other models, such as the U.S. Army Corps of Engineers (USACE) Cap/Recovery model, may be used to confirm CapSim predictions within the biologically active zone.

2.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

17-Mile Lower Passaic River Study Area – River Mile (RM) 10.9 time-critical removal action sediment cap

2.5 Decision

The use of CapSim and other cap models to predict cap performance is allowed by EPA, but the guidelines and limitations discussed herein should be considered when using any such models. Models should not be "black boxes." All input parameters and fate and transport equations need to be presented and transparent. No cap model should be used indiscriminately, and assumptions, limitations, and any deviations from guidance need to be appropriately documented.

2.6 References

Shen, X., D. Lampert, X. Zhang, and D. Reible. 2018. "CapSim: Software for Simulating Contaminant Transport through a Sediment Capping Environment". *Environmental Modelling & Software* Volume 109, November 2018: Pages 104-113. Available at https://doi.org/10.1016/j.envsoft.2018.08.014.

3. Post-Dredge Cover and Verification Approach

3.1 Topic

The Portland Harbor ROD states that residual management layers will be placed as soon as is practicable following dredging within the prism and surrounding area. The ROD also assumed that placement of 12 inches of sand following dredging to cover the exposed sediment surface would isolate any dredge residuals and any remaining contaminated sediment inventory, eliminate the need for additional dredge passes, and ensure the leave surface is clean (EPA 2017).

It is recognized that one of the key factors influencing the effectiveness of dredging-based remedies is the extent of residual contamination following dredging and the management of those residuals following completion of dredging activities (USACE 2008). Placement of residual management layers as soon as practicable following dredging will require accurate delineation of the DOC, rapid verification that contamination exceeding RALs and PTW thresholds has been removed, and evaluation of the generated residuals to determine the thickness and composition of the residual management layer prior to placement.

3.2 Portland Harbor Project Area Where Topic Was Identified

NW Natural Gasco Sediments Site

3.3 Discussion and Basis for Decision

Pre-design investigations (PDIs) will be conducted to define the lateral and vertical extent of contamination exceeding RALs or PTW thresholds to develop a three-dimensional (3D) dredge prism. For larger dredge projects, the 3D dredge prism will be refined into operational dredge management units (DMUs) to facilitate verification that the required contamination has been removed and rapid placement of residual management layers has occurred. It is expected that dredging techniques and equipment will be selected during remedial design to minimize residual generation and dispersal, while best management practices (BMPs) will be employed to contain and manage residuals during construction.

During construction, dredging will proceed on a DMU basis, with consideration of the allowable dredge season based on fish windows and other considerations. Following completion of dredging in each DMU, the DMU will be surveyed to verify that the 3D dredge prism elevations have been achieved. Following verification that dredge prism elevations have been achieved, sediment cores will be installed within the DMU at a density of five sediment cores per acre, with a minimum of two sediment cores per DMU.

Sediment cores will include a sample of the residuals layer and samples collected at 6-inch intervals from below the residuals layer to a depth of 4 feet below mudline. Samples from each interval from each core will be composited into a single sample for each interval within the DMU. The composited sample of the first two 6-inch intervals below the residual layer will be analyzed immediately to verify that all material exceeding RALs or PTW thresholds was removed; deeper sediment core intervals will be archived for potential future chemical analysis. If the initial composite sample concentrations from the first two 6-inch intervals do not exceed RALs or PTW thresholds and none of the underlying core intervals contain NAPL, the DMU will be closed and the dredge will move to the next DMU scheduled in the dredge season. If either of the first two 6-inch intervals exceeds RALs or PTW thresholds or any of the deeper core intervals contain NAPL, additional successively deeper composite samples will be analyzed until the distribution and DOC is determined.

Once it has been verified that the dredge action has removed all material exceeding RALs and PTW thresholds, the chemical composition in the residual layer will be evaluated to determine the thickness and composition (i.e., reactive amendment dose, if applicable) of the residual management layer required to ensure the residual management layer will achieve CULs protective of the benthic community. Further protection of other receptors will be achieved through ongoing reductions through MNR. Residual management layers will be placed in 6-inch lifts and may include reactive amendments such as activated carbon. Additionally, placement of residual management layers will take into account whether the dredge action can be completed within one dredge season and the potential for recontamination from surrounding areas. At the conclusion of all dredging activities, a final residual management layer will be placed across the entire dredge prism and surrounding area that has been impacted by the dredging action. Post-construction and long-term monitoring will be performed to verify that the cleanup objectives have been achieved.

3.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Lower Duwamish Waterway Superfund Site, Lower Fox River Superfund Site, and Hudson River Superfund Site

3.5 Decision

The approach outlined above is predicated on accurate determination of DOC and rapid determination that the dredge action has removed all material exceeding RALs and PTW thresholds. The approach also requires characterization of the generated residuals to determine the thickness and composition of the residual management layer, including the need for reactive amendments such as activated carbon. The residual management layer is required to have a minimum thickness of 12 inches and be placed in two 6-inch lifts.

The process outlined above assumes it is feasible to remove all material exceeding RALs and PTW thresholds and does not consider the need for cap placement should it be determined that removal of material exceeding RALs and PTW thresholds is infeasible.

3.6 References

EPA. 2017. *Record of Decision. Portland Harbor Superfund Site, Portland, Oregon*. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

USACE. 2008. *The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk*. ERDC/EL TR-08-4. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

4. Defining Depth of Contamination during SMA Delineation

4.1 Topic

SMAs were identified in the PHSS FS based on surface sediments. A decision framework is required for delineating DOC in and around SMAs to determine the lateral and vertical extent of contamination exceeding RALs or PTW thresholds and when buried contamination can be left in place. The spatial extent of SMAs will be determined based on existing information and the conceptual site model (CSM) for a site. For cases where buried contamination above RALs or PTW thresholds is left in place, evaluation will be required to assess the physical and chemical stability of contaminated sediments and determine whether exposure to buried contamination above RALs or PTW thresholds may occur in the future.

4.2 Portland Harbor Project Area Where Topic Was Identified

NW Natural Gasco Sediments Site and Terminal 4

4.3 Discussion and Basis for Decision

During remedial design, PPs will need to collect surface and subsurface sediment data to delineate SMAs in three dimensions. The horizontal and vertical extent of sediment contamination exceeding RALs or PTW thresholds will be evaluated to be able to design and construct remedies that are protective of human health and the environment in the long term. The DOC will need to be delineated if the site is known to have NAPL and/or manufactured gas plant waste, or if the area is expected to be dredged. If contaminated sediments exceeding RALs or PTW thresholds are expected to be left in place, EPA will need to be reasonably certain that the buried contamination does not pose unacceptable risk to human health or the environment. EPA will make this determination by considering current and reasonably anticipated future land and waterway use and the potential for contaminated material to become exposed in the future or migrate to a point where exposure may occur.

If only subsurface contamination exceeds RALs and/or PTW thresholds and the expected remedial technology application is capping, full delineation of DOC is not necessary. However, vertical characterization of subsurface sediment contamination will be required to sufficiently characterize material to be left in place to support cap design evaluations (Palermo et al. 1998) or to demonstrate the stability of the buried contamination. This characterization will require collection of site-specific data, including the following:

- Groundwater seepage rates
- Porewater contaminant concentrations
- Sediment contaminant concentrations
- Total organic carbon
- Geotechnical parameters (e.g., grain size, shear strength, specific gravity)
- Hydrological parameters (e.g., currents, prop wash, wave effects)
- Contaminant concentrations in depositing sediment
- Differential bathymetry

Additional data collection may be needed to demonstrate that buried contamination does not present unacceptable risk to human health or the environment under current and reasonably anticipated future conditions. Cap modeling will require site-specific porewater contaminant concentrations, groundwater seepage rates, and organic carbon measurements to effectively demonstrate that the contamination will remain reliably contained (Interstate Technology & Regulatory Council [ITRC] 2014).

4.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Lockheed West Seattle Superfund Site, Lower Fox River Superfund Site

4.5 Decision

Delineation of DOC will be required for sites with NAPL or areas where dredging is the assigned technology. The design implementation of the DOC characterization program will consider existing information regarding the distribution of contamination and a CSM that considers the release mechanism, contaminant characteristics, and hydrodynamic regime, and may include sample locations outside the SMAs identified in the ROD. For sites where NAPL does not exist and/or the sampling location is not within a dredging area, sediments with concentrations exceeding RALs or PTW thresholds at depth may be left in place if it can be demonstrated that the subsurface sediments will remain stable. In such cases, the physical (e.g., erosive conditions, slope stability) and chemical (e.g.., advective and diffusive flux because of seepage) stability of the buried contamination will need to be demonstrated by conducting appropriate evaluations to assess whether the material needs to be capped or to support cap design.

4.6 References

ITRC. 2014. *Contaminated Sediments Remediation, CS-2*. Interstate Technology & Regulatory Council, Contaminated Sediments Team, Washington, DC. Available at http://www.itrcweb.org/contseds_remedy-selection.

Palermo, M., S. Maynord, J. Miller, and D. Reible. 1998. *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments*. EPA 905-B96-004. Great Lakes National Program Office, Chicago, Illinois.

5. Core Sampling Intervals

5.1 Topic

The majority of subsurface sediment core samples were collected over core intervals ranging between 1 and 4 feet during the RI/FS. During remedial design, subsurface sediment cores shall be sampled in 1-foot intervals in dredging areas to accurately characterize the distribution of subsurface sediment contamination and to develop accurate dredge prisms. The minimum 1-foot sampling interval may not be required for capping areas.

5.2 Portland Harbor Project Area Where Topic Was Identified

NW Natural Gasco Sediments Site, Terminal 4

5.3 Discussion and Basis for Decision

Core sampling in 1-foot intervals provides greater resolution for the vertical delineation of contamination. While this may result in increased sampling costs and decreased sample volumes, the greater resolution provided by sampling in 1-foot intervals will minimize the removal, management, and disposal of clean material that is below RALs and PTW thresholds, thus reducing overall remediation costs.

To improve the resolution of the vertical distribution of contamination, all subsurface cores in dredging areas will be sampled in 1-foot intervals. This resolution will provide greater precision during development of dredge prisms. Accurately delineating the dredge removal volume is important because each increment of dredging depth is costly not only for dredging but for subsequent management, treatment, and/or disposal. The 1-foot core intervals will be analyzed for all ROD Table 21 contaminants and all Table 17 COCs for leave surfaces. The use of existing core data to delineate the vertical extent of contamination will be determined on a site-specific basis and will consider the level and depth of contamination and adjacent sediment core data. If existing data do not sufficiently characterize the vertical extent of contamination, additional cores will be required at that location.

For sites where a specific COC is considered to be the risk driver, a systematic approach may be used in which the bottom of each core is analyzed for all Table 21 contaminants and the rest of the core is only analyzed for the risk driver COC. In such cases, a subset of cores will be selected to be analyzed for all Table 21 contaminants for the entire length of the core (top to bottom) to support the risk driver COC correlations. Such an approach will depend on site-specific parameters and will need to be discussed with and approved by EPA during development of PDIs. Alternatively, a hierarchy of COCs for analysis or flexibility in reporting limits may be evaluated in consultation with EPA based on the CSM for a particular site.

For areas where the expected remedial technology is capping, the minimum 1-foot sampling interval will not be required; however, the sample interval must be representative of the material being capped. Even though vertical delineation of contamination in capping areas is not as important as dredging, the vertical distribution is important for the long-term performance of a cap. A relatively thin layer of contamination may be reliably contained by a cap, but a thick layer of contamination or higher concentrations at depth may result in a consistently high or increasing contaminant flux through a cap over time (ITRC 2014).

5.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Lower Duwamish Waterway Superfund Site

5.5 Decision

Subsurface cores will be sampled in 1-foot intervals in dredging areas within an SMA for the purpose of delineating DOC. Based on site-specific parameters and in consultation with EPA, PPs may propose a systematic approach for prioritizing chemical analyses to address concerns regarding sample volumes. Core sampling intervals in capping areas must be representative of the material being capped.

5.6 References

ITRC. 2014. *Contaminated Sediments Remediation, CS-2.* Interstate Technology & Regulatory Council, Contaminated Sediments Team, Washington, DC. Available at http://www.itrcweb.org/contseds_remedy-selection.

6. Under Structure Data Collection during Remedial Design

6.1 Topic

During data collection for remedial design, manual probing or poling with divers may be used to estimate sediment thickness under structures. Probing and poling cannot replace collection of sediment samples to properly characterize contamination under structures and must be used in conjunction with other characterization techniques.

6.2 Portland Harbor Project Area Where Topic Was Identified

Terminal 4

6.3 Discussion and Basis for Decision

Diver probing or poling in areas under structures (e.g., piers, docks) may be used to characterize sediment thickness in areas where extensive riprap is present or where accessibility issues affect coring activities. Although diver probing is useful to estimate sediment depth under structures during remedial investigations, characterization of surface and subsurface sediment for chemical and physical analysis will be required to support remedial design activities. Probing and poling only provide limited physical characterization estimates; chemical characterization of contaminants within an SMA will also be required to design a remedy that is protective in the long term. Areas under structures are subject to tidal pumping and erosional effects, which may impact the effectiveness of a remedy or lead to recontamination if the contamination under structures is not appropriately characterized and addressed by the remedy as needed.

Probing and poling cannot be used as the primary sampling technique under structures, but it may be used to inform subsequent sediment characterization activities. If the only objective of the proposed diver probing or poling is to delineate the riprap, remote sensing applications that provide greater coverage, such as side-scan sonar, should be considered.

6.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

17-mile Lower Passaic River Study Area, Lockheed West Seattle Superfund Site

6.5 Decision

Probing and poling may be used as a preliminary screening tool to estimate sediment depth under structures, but remedial design characterization activities must also include surface and subsurface sediment sampling to chemically characterize the concentrations of contaminants in sediments under structures.

7. Remnant Piling Removal in Remedial Design

7.1 Topic

Remnant pilings present challenges to dredging and capping. In addition to impeding remedial activities, pilings provide preferential but potentially contaminated habitat for smallmouth bass and other fish, as reported by the Oregon Department of Fish and Wildlife (2005). Based on preliminary findings from the Pre-Remedial Design Group's smallmouth bass tracking study, smallmouth bass may reside for extended periods in areas where remnant pilings are located. Increased contaminant exposure to aquatic receptors can occur because sediment with elevated contaminant concentrations is commonly present in areas of remnant pilings and treated pilings may also leach contaminants into the aquatic ecosystem. In addition, pilings may enable predation on juvenile salmonids by piscivorous fish and birds.

7.2 Portland Harbor Project Area Where Topic Was Identified

RM11E

7.3 Discussion and Basis for Decision

It was agreed during a Technical Coordination Team (TCT) meeting on November 19, 2018, that piling removal is recommended, where feasible, to facilitate remedial activities and reduce the unfavorable habitat conditions described above. EPA, the National Marine Fisheries Service (NMFS), the Oregon Department of Environmental Quality, and other members of the TCT agreed that removal of remnant pilings is a priority in achieving RAOs and piling removal should be considered during development of the remedial design. Remnant piling removal is required where feasible.

7.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Lockheed West Seattle Superfund Site, Pacific Sound Resources Superfund Site, Port Gamble Cleanup Project

7.5 Decision

Where feasible, removal of remnant pilings is required in areas of contaminated sediment to enable access for future remedial activities and reduce preferential but potentially contaminated habitat for aquatic receptors.

7.6 References

Oregon Department of Fish and Wildlife. 2005. *Biology, Behavior, and Resources of Resident and Anadromous Fish in the Lower Willamette River.* Final Report of Research, 2000–2004. Edited by T. A. Friesen. Available at https://semspub.epa.gov/work/10/500013028.pdf.

8. 404 Permitting Integration with Institutional Control Plans

8.1 Topic

To ensure in-water activities implemented under Section 404 of the Clean Water Act (CWA) do not adversely impact the effectiveness of the Portland Harbor remedy, the Section 404 permitting process must be integrated with the programmatic ICIAP.

8.2 Portland Harbor Project Area Where Topic Was Identified

Sitewide

8.3 Discussion and Basis for Decision

The selected remedy for the Portland Harbor Site includes ICs to protect and maintain the effectiveness of the remedy. It is expected that the ICs will include sufficient controls to ensure in-water activities implemented under Section 404 of the CWA:

- Do not adversely impact the effectiveness of the Portland Harbor remedy
- Maintain the integrity of the selected remedy
- Prevent exposure to contaminated media over the near and long-term

Parties submitting 404 permit applications and agencies reviewing the applications need to understand whether the proposed in-water action complies with ICs implemented as part of the Portland Harbor remedy and whether the action will adversely impact the effectiveness of the remedy. The approach for integrating ICs into the 404 permitting process is currently under development and will be described in an appendix to the programmatic ICIAP.

8.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

404 permit reviews are conducted in coordination with USACE nationally to ensure, among other considerations, that the subject permit follows ICs as adopted for a sediment superfund site.

8.5 Decision

The approach for ensuring that actions implemented under Section 404 of the CWA are consistent with the programmatic ICIAP is currently under development and will be described in an appendix to the programmatic ICIAP. Once the appendix is prepared, the information in this topic will be updated.

9. Habitat Mitigation

9.1 Topic

PPs may need to provide compensatory mitigation to replace lost aquatic habitats and functions such that there would be "no net loss" of aquatic resources from remedial action(s) at the Site. The details of any necessary compensatory mitigation are to be developed during SMA-specific remedial design. Compensatory mitigation likely will involve the restoration, enhancement, establishment, and/or preservation of shallow water habitat with sand/gravel substrates, shallow slopes, and shoreline complexity conducted specifically for the purpose of offsetting authorized impacts to aquatic resources on-site wherever possible.

The purpose of the following sections is to clarify the process PPs will use to determine and fulfill compensatory mitigation requirements and assure such determinations are made consistently sitewide.

9.2 Portland Harbor Project Area Where Topic Was Identified

Sitewide

9.3 Discussion and Basis for Compensatory Mitigation and Endangered Species Act Approach

The ROD established that remedial designs incorporate measures to be "self-mitigating," to the extent feasible on-site, to maintain aquatic habitats and functions that would be altered as a result of remedial action and to avoid jeopardizing or adversely modifying Endangered Species Act (ESA)-designated critical habitat. This would entail restoring or enhancing the existing substrate, slope, and natural cover to the extent possible, along with implementing additional avoidance and minimization measures and BMPs during construction. The Draft ESA Programmatic Biological Assessment developed for the FS (EPA 2016) describes these measures, and EPA expects to finalize the assessment to cover remedial activities at the Site[1]. These measures will also be described in a project area-specific CWA 404(b)(1) evaluation developed by PPs for their SMA(s).

CWA compensatory mitigation is considered only after other appropriate and practicable options have been incorporated to avoid, minimize, or otherwise rectify unavoidable, adverse impacts on the aquatic environment, including impacts on aquatic species. Situations where compensatory mitigation may be required include placement of rock armoring, changes in slope, and loss of shallow aquatic habitat. Likewise, federal agencies must take measures to avoid jeopardizing the continued existence of an endangered or threatened species or adversely modifying critical habitat.

As discussed further below, shallow water habitat for federally listed salmonids is the primary consideration for aquatic resource impacts; however, habitat for other aquatic species, such as lamprey and sturgeon, should also be considered. In other words, mitigation should address impacts on both listed species under the ESA and impacts on aquatic resources and functions under the CWA. The remedy must comply with applicable or relevant and appropriate requirements, including the CWA and ESA. In addition, as stated in the ROD, the survival guidelines found at Oregon Administrative Rule 635-100-0135 are rules regarding actions that affect species listed under Oregon's threatened or endangered

[1] It is possible that some remedial areas may require a site-specific BA because of complexity.

wildlife species law. The substantive survival guidelines will be incorporated into the remedial design and implementation of the remedy.

PP planning for compensatory mitigation will follow a quantitative approach in coordination with EPA, NMFS, and the U.S. Fish and Wildlife Service. The first step is to ensure remedial designs incorporate measures to be "self-mitigating" to the extent feasible. Following the quantitative method described in the next sections, an evaluation of impacts to ESA-listed species (with a focus on listed salmonids) will then be conducted, along with an evaluation of impacts to other aquatic species or habitat that may require additional mitigation under the CWA.

9.3.1 Habitat Equivalency Analysis

Habitat equivalency analysis (HEA) is used to quantify a mitigation requirement by evaluating the existing habitat functions and values compared to the proposed habitat functions and values after implementing a remedial activity (National Oceanic and Atmospheric Administration [NOAA] 2000). The HEA model has been used by NOAA in the Natural Resource Damage Assessment (NRDA) process since its development in the 1990s. The HEA model has also been used by USACE on various projects around the country to calculate appropriate mitigation requirements under CWA Section 404 since 2002 (Ray 2009).

The HEA for the Site was developed by NMFS and the Portland Harbor Trustee Council and focused on quantifying habitat functions and values important for Chinook salmon at the Site (Portland Harbor Trustee Council 2010). NMFS subsequently modified the relative habitat values (RHVs) to incorporate additional species and life stages. Therefore, the HEA is applicable for evaluating impacts under the ESA for effects on listed species and habitat present at the Site. This approach is also being used for the NRDA process developed and managed by the Portland Harbor Trustee Council. EPA and the Portland Harbor Trustee Council may identify opportunities to coordinate remedial actions and NRDA restoration efforts to increase efficiencies (i.e., cost and time) and benefit natural resources.

The metric used to compare pre- and post-remediation habitat functions and values (i.e., ecosystem services) is discounted service acre years (DSAYs). One DSAY represents the value of all the ecosystem services provided by 1 acre of habitat in 1 year. Services for future years are discounted, placing a lower value on benefits that will take longer to accrue (NOAA 2020).

DSAYs are calculated for the existing condition and the post-remediation condition of a remedial action area using the HEA model. The model accounts for the time necessary for new habitat to achieve full function (e.g., time necessary for planted vegetation to mature and begin providing habitat functions), and habitat benefits provided in the future are discounted relative to habitat benefits provided immediately, generally at a rate of 3% per year.

Inputting the acreages and values associated with each habitat type present at a site before construction, the HEA model can generate the total present habitat value of that site in DSAYs. Similarly, inputting the acreages and values associated with all habitat types planned for after project construction can generate the total habitat value of the site after the project is completed. The pre- and post-project habitat value of the site can then be compared to see if the project has resulted in a credit (the post-project site has a higher habitat value than pre-project site) or debit (the pre-project site has a higher value than post-project site). If construction of a project leads to a situation where the pre-project site had a higher value than the post-project site, then the debit from the HEA model can help inform the amount of mitigation that may be necessary.

The following are inputs required to calculate DSAYs using the HEA model:

- Habitat values (also known as RHVs) developed by NMFS and the Trustees, as modified by NMFS. Each habitat type is assigned a value ranging from 0 to 1, with 1 being the highest and 0 being the lowest value habitat for ESA-listed species (See **Table B9-1**). Pre- and post-project habitat values may be adjusted by NMFS for a given project based on other factors (e.g., presence or absence of contaminants, quality of adjacent habitats, species and life stages present, stream where any proposed mitigation is located).
- Existing site-specific habitat quantities (acres) and condition data collected by the PPs include the following:
    - Riparian habitat: vegetation; substrate; location with respect to historical floodplain; presence of buildings, structures, and riprap
    - Active channel margin (ACM): slope; vegetation; substrate; presence of riprap, sheet pile/seawall, pilings, suspended structures over channel margins (e.g., docks), and floating structures (e.g., docks)
    - Main channel: depth; substrate; presence of riprap, sheet pile/seawall, pilings, and suspended and floating structures
    - Off-channel: tributary water temperature and position relative to main channel (e.g., side channel, alcove or slough, embayment or cove)
- Projected post-remediation habitat quantity and condition data collected by the PPs (same as above, as applicable)
- Timing of the remedial action:
    - Implementation year – year the remedial action was implemented.
    - Base year – year the injury assessment was completed. Base year is assigned to establish a reference point in time to standardize "service acre years" using the discount rate or appreciation rate. This is similar to saying, "we evaluated both injury and the restoration project using 2020 dollars."
    - Years until full function, as defined for each habitat type by NMFS and the trustees.

The HEA model will be used to provide the DSAY calculations for the PPs. An existing condition (or pre-construction) DSAY value will be calculated from the existing habitat values and site-specific quantities, and a post-construction DSAY value will be calculated from the post-remediation habitat values and quantities. The post-construction DSAY will be adjusted by the timing factors and the DSAY calculations will be compared to identify a credit or a debit.

If the HEA model results in a debit, the PPs will be required to develop a compensatory mitigation project or purchase the equivalent DSAY credits from an approved mitigation bank.

Table B9-1. Draft HEA Habitat Values for ESA Consultation in Portland Harbor

Habitat	Habitat Characteristics	Years Until Full Function	Salmonid Value
RIPARIAN (above ordinary high water)	naturally vegetated forest, <400 feet from active channel margin	40[1]	0.5
	and in the historical floodplain	40[1]	0.65
	naturally vegetated, grass/shrub	5	0.2
	and associated with historical floodplain	5	0.35
	invasive species (e.g., Himalayan blackberry)	NA	0.1
	vegetated riprap	NA	0.05
	unvegetated/paved/buildings/riprap	NA	0
ACTIVE CHANNEL MARGIN (between ordinary high water and ordinary low water)	sloped (<5:1 or 11°), unarmored and vegetated (native)	3	1
	sloped (<5:1 or 11°), unarmored and vegetated (invasive)	3	0.5
	sloped (>5:1 or 11°), unarmored and vegetated (native)	3	0.8
	sloped (>5:1 or 11°), unarmored and vegetated (invasive)	3	0.4
	sloped (<5:1), unarmored and unvegetated	1	0.8
	sloped (>5:1), unarmored and unvegetated	1	0.1
	sloped (<5:1), bioengineered	3	0.2
	sloped (>5:1), bioengineered	3	0.2
	riprapped	NA	0
	sheet pile/seawall	NA	0
	pilings	NA	1/2 value of margin type
	suspended structures over channel margins (e.g., docks)	NA	0.1
	floating structures (e.g., docks)	NA	0
MAIN CHANNEL (below ordinary low water)	shallow water, gravel and finer substrates	1	1 (0.9)
	shallow water, natural rock outcrop	NA[2]	1 (0.9)
	shallow water with riprap/concrete/seawall in adjacent shoreline	NA	0.1 (0.1)
	shallow water with suspended structures	NA	0.1 (0.1)
	shallow water with floating structures	NA	0
	shallow water with pilings	NA	1/2 value of channel type
	deep water with natural substrates	1	0.1
	deep water with artificial substrates	NA	0.05
OFF CHANNEL	"cold" water tributary	1	1
	"warm" water tributary	1	0.9
	side channel	1	1
	alcove or slough with tributary	1	1
	alcove or slough with tributary ("warm")	1	0.9
	alcove or slough without tributary	1	0.8
	embayment (cove) with tributary	1	1
	embayment (cove) with tributary ("warm")	1	0.9
	embayment (cove) without tributary	1	0.8

Source: NMFS

Notes:

[1] achieves 80% of full function within 10 years; this time is adequate because of flood protection

[2] cannot be created

The credit for simply removing pilings is limited to 0.1 and for removing covering structures is limited to 0.5.

< = less than; > = greater than; ° = degrees; NA = not applicable

9.3.2 Clean Water Act (CWA) Section 404

As discussed above, while the HEA model specifically addresses effects on ESA-listed species and critical habitat, it may not be adequate for evaluating potential effects to nonlisted species and effects on the aquatic ecosystem from remedial activities. The CWA Section 404(b)(1) analysis requires an evaluation of effects on the broader aquatic ecosystem and associated human uses. These include effects on the physical and chemical characteristics of the aquatic ecosystem (i.e., substrate, suspended particulates/turbidity and dissolved oxygen, surface water quality, current patterns, water circulation and normal water fluctuations, and floodplains). The CWA evaluation must also consider effects on the biological characteristics of the aquatic ecosystem (i.e., threatened and endangered species and species of concern, the aquatic food web, and wildlife). In addition, the evaluation includes effects on water supplies, special aquatic sites, and human use values.

Appendix L of the Site FS (EPA 2016) provides the CWA Section 404(b)(1) evaluation for the Site remedial alternatives considered in the FS. That evaluation assumes the implementation of avoidance and minimization measures during remedial activities. During remedial design, PPs will develop a site-specific 404(b)(1) evaluation. The site-specific 404(b)(1) analysis will describe the existing conditions and functions and compare those with the post-construction anticipated conditions and functions. Because several aquatic functions under the 404(b)(1) analysis can be related to habitat conditions for listed species, some of the aquatic functions may be described by the HEA analysis. For example, physical characteristics that provide habitat functions for salmonids may also provide habitat functions for benthic organisms that support waterfowl. The 404(b)(1) analysis should highlight those characteristics that extend beyond habitat functions for listed species. EPA will determine if mitigation proposed using the HEA model would adequately offset effects on the broader aquatic ecosystem or if additional mitigation would be required. Likewise, the 404(b)(1) analysis may indicate that compensatory mitigation may be necessary even when the HEA model found no mitigation for ESA species or critical habitat was necessary.

The site-specific 404(b)(1) evaluation should consider the draft analysis presented in Appendix L of the PHSS FS and include at a minimum:

a. Expected deviations from any ecosystem impacts assumed in the draft analysis in Appendix L of the PHSS FS and how these are being considered in the site-specific design to ensure lowest overall ecosystem impact.

b. Measures to address short-term construction-related impacts to non-ESA species during construction that are not already being proposed in the BA for ESA species (e.g., special removal methods of lamprey ammocoetes from a dredge prism that are not part of ESA species removal methodology).

c. Measures to address long-term impacts to non-ESA species (e.g., habitat mix layer applied to deeper water caps to support habitat for sturgeon or other species).

The specific information provided will then be considered by EPA when determining what, if any, compensatory mitigation will be required for non-ESA species in addition to that assessed for ESA species, if applicable.

9.3.3 Conducting Compensatory Mitigation

Generally, the 404(b)(1) guidelines provide three ways a PP can meet compensatory mitigation requirements:

- Purchase mitigation credits from an approved mitigation bank
- Purchase mitigation credits from an in-lieu fee program
- PP-lead compensatory mitigation project

The 404(b)(1) guidelines require that compensatory mitigation be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services. Thus, compensatory mitigation projects for remedial action impacts are expected to be located within the Site boundaries; however, if not constructed within the Site boundaries, they should be constructed within the lower Willamette River watershed.

Currently, there are no approved mitigation banks or in-lieu fee programs applicable to the Site. However, the Linnton Restoration Site is under development, as described below, to provide mitigation credits for purchase as an approved mitigation bank.

9.3.3.1 Performing Party-Lead Compensatory Mitigation Projects

PPs can propose a compensatory mitigation project to be constructed at their site or another site in the lower Willamette River watershed. To meet mitigation requirements, the mitigation project generally must restore, create, enhance, and in certain limited circumstances, preserve the same habitat type that was impacted by the remedial action. However, some habitat types, such as off-channel habitat, are more valuable as they are very important for juvenile salmonids and very limited in Portland Harbor.

<u>Example PP-Lead Compensatory Mitigation Project: Dahl Beach</u>

The Port of Portland constructed a compensatory mitigation project at Dahl Beach to offset impacts from the placement of riprap to stabilize the shoreline at Wheeler Bay. Dahl Beach is located on the north bank of the Clackamas River at the confluence of the Clackamas and Willamette Rivers near RM 25. The Dahl Beach mitigation project consisted of removing a failing bulkhead and a parking area and restoring ACM and shallow water habitats to provide benefits for local ESA-listed salmon and steelhead populations and other aquatic species that rely on shallow water areas. The project also restored adjacent riparian habitat, which further augmented the function of the shallow water and ACM habitats by shading open water and contributing to reduced water temperatures, providing cover from predators, and providing food supply for fry, juvenile, and smolt salmon, and steelhead.

The project was constructed in 2016 and plantings were installed in 2017. Effectiveness monitoring is being conducted for 5 years following construction to evaluate habitat features and vegetation success relative to performance standards.

The Dahl Beach mitigation project did not use the HEA model; however, the project was approved by NMFS through a 2008 biological opinion. EPA determined that the project met both ESA and 404 compensatory mitigation requirements.

9.3.3.2 Mitigation Banks

The Interagency Review Team, led by USACE and the Oregon Department of State Lands (DSL), is charged with certifying mitigation banks or in-lieu fee programs through a mitigation banking instrument such that they are approved to sell credits for compensatory mitigation purposes. DSL guidance on how to establish a mitigation bank is available here: https://www.oregon.gov/dsl/WW/Documents/EstablishMitigationBank.pdf. The 404(b)(1) guidelines provide that mitigation banks used to offset unavoidable loss to aquatic resources should be located in the service area where the loss occurs. Therefore, mitigation banks within the Site boundaries or banks whose service area includes the lower 12 miles of the Willamette River will generally be considered for compensatory mitigation for Portland Harbor.

Example Mitigation Bank

In 2019, Linnton Water Credits conducted remedial activities and restoration of the Linnton Mill Site with the intent of providing habitat credits for natural resource damage obligations and other potential 404 mitigation credits to offset impacts from remedial activities. The Linnton Mill Site is within the Site at RM 4.6 West. While still in development, the Linnton Mill Mitigation Bank proposes to generate a total of 510.8 DSAYs (credits), with 325.2 of those DSAYs proposed to be eligible as CWA mitigation credits and ESA conservation credits.

As described above, remedial designs must fully incorporate measures to be “self-mitigating” to the extent feasible on-site to maintain aquatic habitats and functions that would be altered as a result of remedial action. This may preclude the need for off-site compensatory mitigation projects. The ROD estimated that 60 acres of compensatory mitigation will be required across the Site. This estimate is based on the acreage of armored caps to be placed, including 2 acres of armored caps on riverbanks and 58 acres of armored caps on sediment in the shallow waters. This does not account for potential impacts that may result from other remedial technologies; therefore, this may be an underestimate of the total amount of compensatory mitigation that will be required sitewide for the Site.

EPA will coordinate with NMFS to provide an estimate of DSAYs required to compensate for the 60-acre Sitewide estimate of armored caps. It is assumed that the DSAY credits expected from the Linnton Mill Mitigation Bank will not be enough to cover the Sitewide estimate of DSAYs needed. Therefore, PPs will likely need to develop their own compensatory mitigation projects or encourage the development of additional mitigation banks.

9.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Lower Duwamish Waterway Superfund Site (NOAA 2013)

9.5 Decision

PPs may need to provide compensatory mitigation to replace lost aquatic habitats and functions such that there would be no net loss of aquatic resources from remedial action at the Site. The details of any necessary compensatory mitigation are to be developed during SMA-specific remedial design. Compensatory mitigation likely will involve the restoration, enhancement, establishment, and/or preservation of wetlands, streams, or other aquatic resources conducted specifically for the purpose of offsetting authorized impacts to aquatic resources on-site wherever possible.

9.6 References

EPA. 2016. *Draft Final Portland Harbor Feasibility Study*. U.S. Environmental Protection Agency Region 10, Seattle, WA. June.

NOAA. 2000. *Habitat Equivalency Analysis: An Overview*. Damage Assessment and Restoration Program, NOAA, Department of Commerce, Washington, DC.

NOAA. 2013. *Final Lower Duwamish River NRDA Restoration Plan and Programmatic Environmental Impact Statement*. Prepared by the National Oceanic and Atmospheric Administration on behalf of the Lower Duwamish River Natural Resource Damage Assessment Trustee Council, Seattle, Washington.

NOAA. 2020. *Damage Assessment, Remediation, and Restoration Program*. Habitat Equivalency Analysis Webpage. NOAA, Department of Commerce, Washington, DC. Accessed March 17, 2020 at https://darrp.noaa.gov/economics/habitat-equivalency-analysis.

Portland Harbor Natural Resource Trustee Council. 2010. *Portland Harbor Superfund Site Natural Resource Damage Assessment Plan.* Prepared by Stratus Consulting for the Portland Harbor National Resource Trustee Council, Portland, Oregon.

Ray, G.L. 2009. *Application of Habitat Equivalency Analysis to USACE Projects*. Ecosystem Management and Restoration Research Program. ERDC TN-EMRRP-EI-04. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

10. Data Replacement

10.1 Topic

Surface sediment data from the RI/FS dataset may not represent current surface sediment conditions at the different project areas of the Site. PPs in remedial design may develop their own site-specific data replacement strategy, as approved by EPA, and the strategy must meet reasonable standards and considerations. These considerations will include the presence of outliers, heterogeneity of the substrate, natural recovery occurrence, deposition, erosion/scour potential, sampling density/resolution, and age of the data. As discussed in Section 1.4 of the RDGC, replacement will be determined on a site- and location-specific basis using trends over time. The following guidelines can be followed to fulfill EPA's requirements for a data replacement evaluation for project areas at the Site.

10.2 Portland Harbor Project Area Where Topic Was Identified

Terminal 4

10.3 Discussion and Basis for Decision

Surface sediments subject to ongoing temporal change that are characterized by samples thought to be outdated could be considered for replacement, provided that plans for replacement follow general guiding principles: (1) spatial configuration should provide improved basis for lateral and vertical delineation of deposits; (2) generally, the number of samples per unit area should increase relative to the RI/FS data; and (3) based on experience at other sediment superfund sites (LimnoTech 2010), additional sampling should be anticipated as remedial designs progress from the basis of design to 30% and subsequent levels of remedial design. Core samples collected below the surface sediment layer (0 to 30 centimeters), or from areas that have been buried with recent deposition should not be considered for replacement. Further, RI/FS surface samples from areas that have been buried with recent sediment deposition should be treated as subsurface samples in the remedial design process. Other considerations for data replacement include the presence of outliers, heterogeneity of the substrate, natural recovery occurrence, deposition, erosion/scour potential, and age of the data (see RDGC Section 1.4).

The objective of the PDI is primarily to improve spatial resolution of contaminant deposits. Any data replacement should enhance this effort to accurately resolve the spatial bounds of the distribution. RI/FS data should only be replaced when concentrations have changed substantively over time and when spatial resolution is at least maintained or improved. The approach to making data replacement decisions is as follows:

1. Divide the area into strata based on geomorphic and anthropogenic site characteristics where a similarity exists (e.g., based on shallow, intermediate, or navigation channel zone; future maintenance dredge [FMD]/non-FMD; in/off main channel; depositional or nondepositional, etc.).

2. For data replacement decisions, perform point-by-point matching. Develop Thiessen polygons for the RI/FS data. Pair RI/FS samples with the nearest PDI or 2018 to 2019 PDI/baseline sampling (BL) sample within each Thiessen polygon and compare concentrations to ROD Table

21 focused COCs. Confirm if current concentrations in surface sediments, on a project area basis and within the same geomorphic and anthropogenic regions, are statistically significantly[2,3] and scientifically meaningfully (i.e., balance the objectives of spatial resolution with temporal change) different from concentrations in samples from the RI/FS period.

   a. If so, consider replacing selected older samples with newer samples by following the approach in #3 below.

   b. If not, combine RI/FS data with newer data and treat as equally important.

3. Using the RI/FS based Thiessen polygons developed in #2, do the following:

   a. Identify those Thiessen polygons that contain no new samples and retain those RI/FS data.

   b. Identify other Thiessen polygons that do contain new samples and replace those RI/FS samples with the nearest new sample.

Notes

- Statistical comparisons used to determine temporal changes in sediment concentrations must pair RI/FS samples with the nearest PDI sample within each RI/FS-based Thiessen polygon and compare those data (taking into account the effect of detection limits), with samples that cannot be rank-ordered treated as tied observations. For more details, see Helsel 2004.

- The 150- by 150-foot sediment sampling grid discussed in Section 5.1.2 of the RDGC is applicable for SMA delineation and is intended to augment RI/FS data to proceed toward the basis of design report (BODR) with anticipation of higher resolution data to be collected for remedial design and data replacement purposes.

- Adequacy of the sampling design density is conditional on the anticipated remedial design. For example, a broad-scale dredge and cap remedy would require little additional data. Conversely, a design for strategic remediation of deposits requires a higher spatial resolution to ensure accuracy of SMA delineation. Arguments that lead to the conclusion of no action or dramatically smaller SMAs than those identified in the ROD would require much higher data densities and additional investigations supporting a new CSM.

Frequently Asked Questions

Following are a set of frequently asked questions, and EPA responses as they relate to issues of data replacement.

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[2] Statistical significance can be demonstrated using paired nonparametric tests such as the Wilcoxon signed-rank test. Other statistical tests can also be used in consultation with EPA.

[3] If there is little or no uncertainty in individual values (i.e., no nugget effect), then points can be directly substituted without statistical testing. Specific statistical evaluations should be discussed with EPA and data replacement decisions will be made in consultation with EPA.

Q1: What is the appropriate stage during remedial design to conduct data replacement?

A1: Data replacement evaluations will be conducted using project area PDI data and 2018 to 2019 PDI/BL data. Therefore, data replacement evaluations will be conducted after collection of PDI data; however, data replacement can be taken into consideration while developing the PDI work plan (WP) if the performing party expects to follow through with data replacement at their project area.

Q2: Which datasets are eligible to be replaced based on EPA's data replacement approach?

A2: The RI/FS surface sediment dataset may be replaced based on data replacement evaluations. The 2018 to 2019 PDI/BL data is considered to be new data and cannot be replaced.

Q3: Does EPA require the use of three-point composite surface grab samples for data replacement?

A3: EPA prefers the use of three-point composite surface grab samples for data replacement purposes. However, the use of surface intervals from sediment cores may be allowed based on site-specific considerations and upon consultation with EPA.

Q4: Do all focused COCs need to demonstrate similar trends for data replacement to be approved?

A4: All ROD Table 21 focused COCs should demonstrate similar trends in concentration changes over time to confirm the validity of the observed changes. Data replacement based on project area-specific driver COCs may be considered in consultation with EPA.

Q5: Is data replacement allowed for an individual sample or localized area if multiple new samples are added in its vicinity?

A5: Sampling plans preferentially targeting individual extreme values for subsequent replacement are not acceptable without considerable supporting rationale and discussion with EPA. As described in EPA's data replacement approach (Appendix B of the RDGC), EPA envisions data supporting remedial design increasing in density and extent in such a way that contaminant deposits can be delineated accurately and so that designs can be developed which are both efficient in targeting contamination for remediation with minimal action taken for nontarget materials. Arguments that lead to the conclusion of no action or dramatically smaller SMAs than those identified in the ROD/ESD would require much higher data densities and additional investigations supporting a new CSM.

Q6: What sampling density is required for data replacement?

A6: A prescribed sampling density may not be applicable for all project areas within the site because of site-specific differences and interactions between remedial technologies and the amount of data needed to support the assigned remedial technology. For example, if PPs incorporate remediating beyond uncertainty bounds for deposits, little data are needed because the contamination is removed along with substantial nontarget sediment. Conversely, if the design is intended to take a more exact approach by carefully differentiating target and nontarget material, much greater sampling density would be required. Each performing party should propose a sampling density that supports their specific design and remediation technology assignments, including discussion of plans for additional infill sampling as the design and construction proceed. The 150- by 150-foot sediment sampling grid discussed in RDGC Section 5.1.2 is applicable for SMA delineation and is intended to augment RI/FS data to proceed toward the BODR with anticipation of higher resolution data to be collected for remedial design and subsequent data replacement and infill purposes.

10.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

10.5 Decision

At the PP's option, all surface RI/FS data can potentially be replaced with new design data collected at a sufficient density to adequately delineate deposits to support planned design approaches by following the three steps in **Section 10.3**. It should be noted that:

1. Data density could be relatively low if the PP plans to remediate extensive areas and there is little chance of missing target sediments. Such an approach would likely include remediation of significant areas of nontarget sediments to ensure target sediments are not overlooked.
2. Data density would need to be much greater if the PP wishes to minimize SMA footprints and volume remediated while maintaining low probability of leaving target sediments in place after remediation. As stated in Sections 10.1.1.9 and 14.2.7 of the ROD, sampling will include a statistically valid collection of data.

10.6 References

CDM Smith. 2016. *Feasibility Study, Portland Harbor RI/FS*. Prepared for the U.S. Environmental Protection Agency Region 10, Seattle, Washington.

Helsel, D.R. 2004. *Nondetects and Data Analysis: Statistics for Censored Environmental Data*. First Edition. John Wiley & Sons, Inc., Hoboken, New Jersey.

LimnoTech. 2010. Potential Benefits of Infill Sampling at Varying Densities, Fox River/Green Bay Operable Unit 4. Prepared by John Wolfe, John Kern, and Noemi Barabas for the Lower Fox River/Green Bay Working Group 4, Ann Arbor, Michigan.

11. Contaminant of Concern Requirements

11.1 Topic

These guidelines are intended to provide direction on the appropriate application of ROD Tables 17 and 21 during remedial design. As specified in the ROD and ROD decision tree (ROD Figure 28), capping and/or dredging will occur in SMAs, which are areas exceeding RALs or PTW thresholds. Table 17 CULs are the long-term contaminant concentrations that need to be achieved to meet RAOs.

The following guidelines provide additional discussion of the chemical characterization requirements for different sampling objectives during remedial design and include a table summarizing these requirements.

11.2 Portland Harbor Project Area Where Topic Was Identified

Sitewide

11.3 Discussion and Basis for Decision

11.3.1 Sediment Management Area Delineation
SMA delineation and refinement in PDI WPs must include all contaminants listed in ROD Table 21 (focused COCs and additional contaminants). If a PP has a technical rationale for excluding a specific Table 21 contaminant (e.g., chlorobenzene) based on their CSM and empirical data, this can be discussed with EPA during development of the PDI WPs. However, EPA recommends that an evaluation of driver COCs be reserved until after completion of the PDI.

11.3.2 Leave Surface Characterization
Per Section 14 of the ROD, contaminated sediment will be dredged to the depth required to achieve RALs and remove PTW, or to the depth required to allow placement of a cap or backfill material. Confirmation sampling will be required after completion of dredging in a DMU to confirm contamination exceeding RALs or PTW thresholds has not been left behind. The list of analytes for leave surface characterization must include analysis of all ROD Table 17 contaminants having a riverbank soil/sediment CUL. This information may be used to determine if placement of a residual management layer is sufficient or if a cap will be required such that contaminant concentrations in the top 30 centimeters are below CULs.

11.3.3 Cap Design
Cap design modeling will need to demonstrate that the cap can contain contaminant concentrations in the top 30 centimeters of the sediments and associated porewater below the Table 17 CULs for the design period of 100 years. Additionally, isolated sediments beneath the cap need to have concentrations less than the PTW thresholds for the not reliably contained COCs in ROD Table 21. Since cap design and long-term monitoring of caps will require compliance with riverbank soil/sediment and groundwater CULs for ROD Table 17 contaminants, consideration should be given to sampling Table 17 contaminants in areas where the expected remedial technology is capping.

11.3.4 Riverbank Characterization

Appendix D of the RDGC requires riverbank characterization to include all ROD Table 21 contaminants and Table 17 contaminants having a riverbank soil/sediment CUL. If results exceed PTW thresholds, subsurface sampling is required to vertically bound the contamination to the depth appropriate to support remedial design. If results exceed CULs and/or RALs, vertical delineation of the extent of contamination would proceed to the depth appropriate to meet the investigation DQOs developed in a preapproved PDI WP. RDGC Appendix D should be referenced for additional details.

11.3.5 Table 16 Application

In addition to the abovementioned uses of ROD Tables 17 and 21 during remedial design, consideration should be given to the contaminants posing potentially unacceptable risk listed in ROD Table 16. As stated in Section 8.2.5 of the ROD, contaminants posing potentially unacceptable risk will be compared with post-remedial action conditions to confirm the remedial action would also be protective of risks of lower ecological significance. PPs should consider ROD Table 16 contaminants in remedial design given that five-year reviews will evaluate whether the remedy is protective of ecological receptors. ROD Table 16 lists contaminants posing unacceptable risk to receptor groups..

Table B11-1. COC Requirements Summary Table

Remedial Design Sampling Stage	Sampling Objective	ROD Table			Comments
		Table 21	Table 17	Table 16*	
PDI/BODR	SMA delineation/ refinement	X		X	Focused COCs and additional contaminants
PDI	Leave surface characterization	X	X	X	Table 17 contaminants can be reduced to area-specific driver COCs based on CSM
PDI/BODR	Cap design	X	X	X	Table 17 contaminants can be reduced to area-specific driver COCs based on CSM
PDI	Riverbank characterization	X	X	X	Table 17 contaminants with riverbank soil/sediment CULs; can be reduced to area-specific driver COCs based on CSM

* Characterization of all Table 16 contaminants is not a requirement for remedial design. However, EPA recommends consideration of Table 16 during remedial design consistent with Section 8.2.5 of the ROD.

11.4 Sites Outside Portland Harbor Where a Similar Approach Was Used

Not applicable

11.5 Decision

The application of ROD Tables 21 and 17 for chemical characterization must be consistent across the Site, where characterization of ROD Table 21 contaminants is used to define areas requiring active remediation (dredging and/or capping) and characterization of ROD Table 17 contaminants may be needed for leave surface characterization, cap design, and riverbank characterization. Any reductions to ROD Tables 21 and 17 contaminant lists will require EPA approval. Additionally, consideration should be given to the contaminants posing potentially unacceptable risk listed on ROD Table 16. For contaminant requirements related to long-term monitoring, see RDGC Appendix C.

Appendix C

Monitoring Requirements and Remedy Implementation Performance Standards

Portland Harbor Superfund Site

Monitoring Requirements and Remedy Implementation Performance Standards

April 23, 2021

Table of Contents

Tables

1 Introduction

Active remedial measures to be implemented in Portland Harbor Superfund Site (Site) sediment management areas (SMAs) include dredging, capping, and in situ treatment for contaminated sediments, and removal, capping, and erosion control measures for riverbank soils. Areas outside SMAs will be addressed via monitored natural recovery (MNR) and enhanced natural recovery (ENR). The sediment and riverbank remedies described in this document are expected to be implemented by performing parties (PPs) as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions under U.S. Environmental Protection Agency (EPA) oversight. Riverbank remedies being implemented as CERCLA actions will follow Appendix D of the Remedial Design Guidelines and Considerations (RDGC). Source control measures, including some riverbank remedies, are expected to be implemented under Oregon Department of Environmental Quality oversight.

This document describes the monitoring requirements and performance standards that will assess degree of remedy effectiveness and progress toward achieving remedial goals. The monitoring details discussed in the following sections provide general guidance to PPs. Project area-specific implementability concerns will be determined by EPA and during review of PP remedial design deliverables, with participation and review by the Technical Coordination Team (TCT).

The monitoring will be implemented at different project stages and have varying objectives. This monitoring includes:

- Construction monitoring – Table 1
- Remedy performance monitoring – Table 2
- Remedial action objective (RAO) monitoring – Table 3

EPA expects that construction monitoring will be used to assess whether the remedy was constructed as designed, performance monitoring will be used to assess whether the remedy is performing as designed, and RAO monitoring will assess the long-term effectiveness of the remedy at achieving the RAOs. Construction monitoring will occur on a project area basis during and immediately after remedy construction to determine if the design specifications have been achieved. Performance monitoring will be conducted periodically following construction to evaluate whether the selected remedial technology is performing as designed. RAO monitoring will evaluate the degree of effectiveness of active remedies, ENR, MNR, and implementation of source control measures in attaining RAOs over the long term during five-year reviews. RAO monitoring will be conducted on both a Sitewide and project area basis to evaluate progress toward meeting RAOs 1 and 5 (sediment monitoring), RAOs 2 and 6 (biota monitoring), RAOs 3 and 7 (surface water monitoring), RAOs 4 and 8 (groundwater/porewater monitoring), and RAO 9 (riverbanks monitoring). **Section 4** provides requirements for each type of monitoring.

2 Sediment Remedies

This section summarizes and clarifies the selected remedy but does not supersede any requirements presented in the Site Record of Decision (ROD) or Explanation of Significant Differences. As noted in the ROD, SMAs represent areas where containment or removal technologies are required and are defined by exceedances of remedial action levels (RALs) and/or the presence of principal threat waste (PTW).

SMA boundaries will be refined during remedial design based on full characterization of horizontal and vertical contamination extents. Contaminated sediment remedial technologies will be applied based on location (i.e., navigation channel, future maintenance dredge areas, intermediate region, shallow region, and riverbank region), structures, and the presence of PTW, as presented in the technology application decision tree shown on ROD Figure 28 and described in ROD Section 14.2. Consistent with the ROD, objectives for each sediment remedy type are outlined below.

2.1 Dredging

Dredging will occur as specified in ROD Section 14.2 followed by placement of a post-dredge residual management layer[1], backfill material, and/or engineered cap. Dredging will target removal of contaminated sediment exceeding the RAL and/or PTW thresholds specified in ROD Table 21 or to the feasible depth limit of the excavation technology, as approved by EPA. If RALs are not achieved or PTW is present below the feasible depth limit of the excavation technology, then a cap or backfill will be required instead of the residual management layer. Sampling to delineate the depth of contamination will be conducted prior to remedial action to determine the required removal depth and to develop a three-dimensional dredge prism. Efforts should be made to minimize residuals, maximize the probability of a single dredge pass that meets design specifications in an area, and minimize the time between dredge completion and placement of the residual management layer. The long-term goal of dredging-based remedies is to achieve RAOs via MNR following removal and placement of residual management or backfill material. Where dredging is performed to allow adequate depth for cap placement, the objectives specified for capping will apply.

2.2 Capping

Capping may be conducted in conjunction with sediment removal or as a stand-alone remedy to address contaminated sediments that exceed the RALs and/or PTW thresholds specified in ROD Table 21. Sediment caps will be designed to prevent exposure to the underlying sediments, reliably contain the transport of particulates and dissolved contaminants of concern (COCs) from the underlying contaminated sediment or groundwater plume into the cap surface and the water column, and prevent erosion to ensure the cap remains in place when subjected to natural and anthropogenic erosive forces.

Sediment caps will be designed such that the armor layer will be physically stable under flow conditions associated with a 100-year flood event, reasonably anticipated wind- and vessel-generated waves, and propeller scour (see RDGC Sections 5.2.2 through 5.2.6). In addition, caps will be designed to avoid unacceptable flood rise or diminished flood storage consistent with Executive Orders for Floodplain Management (Executive Orders 11988 and 13690) and Federal Emergency Management Agency regulations (see RDGC Section 5.2.11). Caps will also be designed for climate change resiliency and seismic impacts (see RDGC Section 5.2.5 and 5.2.12). The cap may be augmented with low permeability and reactive amendments, as necessary based on design level modeling, to prevent the breakthrough of

[1] The residual management layer, assumed in the ROD to be 12 inches thick, refers to cover material placed as soon as possible after dredging within the dredge prism and surrounding area. This is not to be confused with the residual mixing zone or the generated residuals layer. Generated residuals are contaminated post-dredging surface sediments that are dislodged or suspended by the dredging operation and are subsequently redeposited on the post-dredge surface. The residual mixing zone is the vertical extent of mixing of generated residuals with the residual management layer (i.e., post-dredge cover).

COCs in the top 0 to 30 centimeters (cm) (see **Section 4.2.2**) for at least 100 years based on project area-specific measurements of groundwater seepage rates and COC concentrations in porewater. The goal of capping-based remedies is to prevent exposure to the underlying material and to reduce migration of COCs in groundwater to sediment and surface water such that cleanup levels are achieved, at the appropriate location and spatial scale.

2.3 In Situ Treatment

In situ treatment will use placement of reactive amendments and will be designed to address contamination underneath and around pilings, docks, berthing or mooring dolphins, and other structures servicing active wharfs or shore-based facilities that will remain intact. Design of in situ treatment areas will consider future maintenance of structures. The concentration and type of treatment amendment will be determined during remedial design. However, the selected amendment must limit contaminant migration sufficiently to meet the RAOs and minimize the potential for adverse impacts to the benthic community and other aquatic organisms. The goal of in situ treatment-based remedies is to reduce migration of COCs in groundwater to sediment and surface water such that cleanup levels are achieved, at the appropriate location and spatial scale. Because in situ treatment does not reduce bulk sediment concentrations, porewater monitoring should be used as the primary line of evidence to determine reduction in dissolved contaminant concentrations.

2.4 Enhanced Natural Recovery

ENR will use the placement of a thin layer sand cover (assumed to be 30 cm in the ROD) to enhance natural recovery processes such as deposition, which are already occurring at portions of the Site. Consistent with the ROD's selected remedy, ENR will be used to enhance or accelerate natural recovery processes within areas outside of SMAs in Swan Island Lagoon to meet cleanup levels within an acceptable timeframe. The acceleration can occur through several processes, including increased dilution of contaminant concentrations in sediment from mixing, thereby decreasing the exposure of organisms to contaminants.

2.5 Monitored Natural Recovery

Cleanup level attainment in dredging areas (post-dredging) and areas outside SMAs will rely on MNR. The effectiveness of MNR will depend in large part on the surface sediment chemical concentrations and the chemical concentration, deposition rate, and mixing extent of the cleaner, depositing sediment. The effectiveness of MNR in achieving cleanup levels will be evaluated based on the results of the Sitewide RAO monitoring, which will include multiple media such as sediment, riverbank soil, surface water, groundwater, porewater, sediment trap, and fish/shellfish tissue samples from upstream, within, and downstream of the Site, and the results of hydrographic surveys.

3 Riverbank Soil Remedies

Consistent with the Portland Harbor ROD, remediation of some contaminated riverbanks is included in the selected remedy where contaminated riverbanks are next to contaminated in-river SMAs or it is determined that the contaminated riverbank should be addressed in conjunction with the in-river actions to protect the sediment remedy. The identification, characterization, and remediation of contaminated riverbank soils shall be performed in accordance with the Appendix D of the RDGC. **Tables 1 and 3** currently have placeholders for monitoring related to riverbank remedies pending further discussions with the TCT and project area-specific discussions with PPs. Once EPA reaches a decision based on these discussions, riverbank monitoring requirements will be revised as needed.

4 Monitoring and Remedy Performance Standards

Per ROD Section 14.2.7, monitoring will be used to determine short- and long-term remedy performance (e.g., reduction and maintenance of sediment contaminant levels), and short- and long-term risk reduction (e.g., decreases in fish tissue contaminant levels or benthic toxicity). Monitoring at the Site will be conducted as described under the categories discussed in this section, based on different stages of the remedial action. The project area-specific details of the monitoring plan(s) will be developed in the project area monitoring plan (PAMP). The PAMP is to be developed by PPs during remedial design based on project area-specific construction details and the conceptual site model. The rationale for proposed sampling densities for all types of monitoring will be provided in the PAMP for EPA approval, with participation and review by the TCT. Remedy construction quality assurance and water quality monitoring during construction will be addressed separately in project area-specific construction quality assurance/quality control plans (CQA/QCPs) and Clean Water Act analyses. Additionally, monitoring to evaluate impacts to surrounding communities will consider air quality, odor, noise, light, and any other parameters deemed necessary during development of the project area CQA/QCP.

4.1 Construction Monitoring

Construction monitoring will include sampling to confirm that the remedial requirements and design specifications specified in the ROD have been achieved. This document does not establish monitoring requirements for impacts to surrounding communities that will be monitored during construction, such as air quality, odor, noise, and light. The project area-specific CQA/QCP will address those community impact parameters and any other parameters deemed necessary based on project area-specific circumstances. Construction monitoring will include hydrographic surveys (e.g., multibeam bathymetry, single beam bathymetry, lidar) to confirm the removal depth was achieved and confirm the thickness of any placed materials (e.g., sediment caps, backfill or in situ treatment, ENR, residual management layers). This monitoring will also include confirmation sampling to confirm there is no missed contaminant inventory and placed materials are below Table 17 cleanup levels. The lateral extents of cap, dredge, and ENR areas will be confirmed to ensure as-built conditions conform with the design and to support project area institutional control data needs. Construction monitoring will be conducted during and immediately after construction as detailed in **Table 1**. The rest of **Section 4.1** focuses on construction monitoring details for dredging, capping, and ENR. Additional construction monitoring activities may be specified during remedial design on a project area-specific basis and alternative means and methods for construction monitoring may be developed in coordination with EPA during remedial design.

Ex situ testing will be conducted on imported materials to be used for the dredge cover, cap isolation, and ENR layers. Chemical analyses will be conducted to verify that concentrations of imported materials are below applicable Table 17 sediment cleanup levels, and physical parameters such as total organic carbon (TOC) and grain size will be characterized to meet design specifications.

4.1.1 Dredging

Following completion of dredging activities, hydrographic surveys will be conducted to confirm the removal depth throughout the EPA-approved dredge certification unit (DCU) was achieved per the design specifications. Tolerances for design elevations will depend on monitoring means and methods. These tolerances will be determined during remedial design based on industry standards. However, EPA recommends the design elevation is met within 95% of the DCU, consistent with construction monitoring at other sediment superfund sites[2]. Immediately after verifying the design elevations have been achieved, confirmation cores (e.g., five sediment cores per acre with a minimum of two cores per DCU) will be collected within each DCU to characterize the leave surface and generated residuals layer, and to verify that the removal activity achieved the applicable RALs and PTW thresholds. The leave surface is defined as material left in place below the removal depth and does not include the generated residuals layer. EPA supports using an operationally defined generated residuals layer thickness for convenience and consistency during project planning, but the thickness of the generated residuals layer will be confirmed based on dredge confirmation core observations. Confirmation samples below the operationally defined residuals layer will be collected at predetermined intervals (e.g., 6 inches) from each core, and samples from each interval may be composited into a single sample for each interval in the DCU. Confirmation sample intervals should not be greater than 1 foot to be consistent with the resolution of dredge prism delineation sample intervals used during the pre-design investigation. If the first two intervals below the generated residuals layer interval have concentrations below RALs and PTW thresholds, EPA will approve dredging closeout in the DCU. If either of the first two intervals exceed RALs and/or PTW thresholds, archived discrete samples for that interval and successively deeper composite samples will be analyzed until the distribution and depth of contamination is delineated. The need for additional measures will be determined in coordination with EPA. If either the survey or confirmation sampling results show that the sediment removal requirements were not met within the DCU based on two consecutive confirmation core intervals, then additional sediment in the DCU shall be removed until compliance with the dredge design specifications is achieved or an engineered cap is placed in accordance with the ROD technology application decision tree and design requirements. The generated residuals layer interval composite sample will be analyzed and compared to the residual management value[3]. If there are no exceedances of the residual management value in the generated residuals layer, the residual management layer will be placed as soon as possible. If there are exceedances of the residual management value, expedited evaluations will be conducted to determine appropriate additional measures, such as increasing the thickness of the cover or adding amendments.

In dredging only areas, once the removal depth has been confirmed and there is no missed inventory, the residual management layer (assumed to be 30 cm in the ROD) will be placed as soon as practicable to minimize the potential for releases of contamination. The thickness of the residual management layer

[2] Parsons. 2011. *Phase 2 Dredging Construction Quality Control/Quality Assurance Plan for 2011*, Appendix A to the *Remedial Action Work Plan for Phase 2 Dredging and Facility Operations in 2011*, Hudson River PCBs Superfund Site. Prepared on behalf of General Electric.

[3] The residual management value is calculated using 15% of the concentration in the generated residuals layer in the bottom 2 inches of the residual management layer as recommended by the U.S. Army Engineer Research and Development Center memorandum *Review and Recommendations on Dredge Releases and Residuals Calculations from the Portland Harbor Draft Feasibility Study,* dated May 24, 2013. Performing parties will develop the residual management values applicable to their project areas in coordination with EPA.

will be verified for each DCU using physical and hydrographic surveys and chemical analyses will be conducted to verify that concentrations in 0 to 30 cm of the placed cover material are below ROD Table 17 sediment cleanup levels. If the residual mixing zone is within the top 30 cm, any associated exceedances can be evaluated on a case-by-case basis in coordination with EPA. Construction confirmation sampling will be described in the applicable remedial action work plan and consider factors such as location, contaminant type and distribution, number, and size of dredge management units (DMUs) and DCUs, removal depth and lateral extent, and required residual management layer. The maximum size of a DCU will be 1 acre. A DCU may be a subunit of DMUs being used in a project area or it may be the same as a DMU for a project area. DCUs will be used to certify dredge completion and closeout, while DMUs are generally determined based on operational requirements.

In capping and dredging areas, once the post-dredge surveys and confirmation sampling results confirm the design specifications were met in the area, the placement of backfill or capping material shall proceed consistent with the selected remedy and cap construction will be monitored as discussed in **Section 4.1.2** below. In areas where backfill or capping material is not required, no further action will be required beyond placement of the residual management layer. Consistent with ROD Section 14.2.9.2, "Residual management layers will be placed as soon as is practicable following dredging within the prism and surrounding area." A residuals management layer will be placed at the end of each dredging season in areas where dredging of a particular DCU is not completed in a single season. Project area CQA/QCP documents and monitoring during and immediately post-construction, where appropriate (e.g., with sediment traps) will establish the appropriate residual management layer placement extents in consultation with EPA based on this ROD requirement. Chemical analyses will be used to verify concentrations of residual management layer materials are below Table 17 sediment cleanup levels at time zero (i.e., immediately after construction). This may be verified by ex situ testing of imported cover materials prior to placement (e.g., based on at least one bulk sample per 500 cubic yards of material, consistent with RDGC Section 5.1.7), and/or testing via coring the placed materials. Based on experience at other sediment Superfund sites, EPA recommends chemical analysis of placed materials to ensure a full understanding of any SMA specific trends for evaluation in the first five-year review. In situ coring of backfill/cover material will not only provide verification that the top 30 cm are below sediment cleanup levels, but can also be used to verify the thickness and uniform placement of backfill or the residual management layer. Physical parameters such as TOC and grain size will also be characterized to confirm design specifications are met.

Backfill/cap and residual management layer placement will be initiated as soon as practical once all adjacent and upstream dredging within the project area is complete. Tolerances for design elevations will depend on monitoring means and methods. These tolerances will be determined during remedial design based on industry standards. However, EPA recommends the design elevation is met within 95% of the DCU, consistent with construction monitoring at other sediment superfund sites[4]. Monitoring will also evaluate sediment surface elevations with regard to shallow water habitat impacts.

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[4] Parsons. 2001. *Phase 2 Dredging Construction Quality Control/Quality Assurance Plan for 2011*, Appendix A to the *Remedial Action Work Plan for Phase 2 Dredging and Facility Operations in 2011*, Hudson River PCBs Superfund Site. Prepared on behalf of General Electric.

4.1.2 Capping

Cap placement will proceed where required according to the approved cap design once all adjacent and upstream dredging within the project area is complete. The specifics associated with the timing of cap construction and monitoring activities will be determined during remedial design based on appropriate sequencing of remedial actions at all project areas within the Site.

For cap and backfill placement, physical (e.g., small-diameter sediment cores, catch pans or stakes, sediment profile image surveys, bucket surveys, dive surveys, and/or mass balance approaches) and hydrographic surveys will be performed to verify the material placed meets the design specifications, including minimum cap/backfill thickness. Tolerances for design elevations and thicknesses will depend on monitoring means and methods, which will be determined during remedial design based on industry standards. However, EPA recommends the design elevation/thickness is met within 95% of the cap certification unit (CCU). A CCU will be a maximum 1-acre cap area used to certify cap construction. For armored caps, hydrographic surveys will be conducted before and after placement of the armor layer to ensure design specifications are met, including minimum armor layer thickness. The specifics of material placement monitoring will be determined during remedial design and included in the PPs CQA/QCP.

After the chemical isolation layer of a cap has been constructed, EPA recommends collecting small-diameter cores to confirm that the cap is constructed as designed (e.g., layer thickness, composition, amendment dosage). Coring is the most reliable method to verify uniform placement; this would need to be done before placement of armor and habitat layers so that more reactive amendment could be added and/or cap thickness could be adjusted as needed. Chemical concentrations may be measured in the capping materials ex-situ before placement so the small-diameter cores may not need to be analyzed for chemical concentrations. However, based on experience at other sediment Superfund sites EPA recommends chemical analysis of placed materials to understand the extent of intermixing with underlying sediments or generated residuals. Chemical analyses will be used to verify that concentrations of cap materials are below ROD Table 17 sediment cleanup levels at time zero (i.e., immediately after construction). As indicated in **Table 1**, this may be verified by ex situ testing of imported cap materials prior to placement (e.g., based on at least one bulk sample per 500 cubic yards of material, consistent with RDGC Section 5.1.7), or testing via coring the placed cap materials. Physical parameters such as TOC and grain size will also be characterized.

4.1.3 ENR

Construction monitoring for ENR will be based on physical and/or hydrographic surveys to verify placement of the thin-layer sand cover meets the design specifications, including minimum thickness, throughout the EPA-approved ENR certification unit. Chemical analyses will be used to verify that concentrations of ENR layer materials are below Table 17 sediment cleanup levels at time zero (i.e., immediately after construction). This may be verified by ex situ testing of imported cap materials prior to placement (e.g., based on at least one bulk sample per 500 cubic yards of material, consistent with RDGC Section 5.1.7), or testing via coring the placed materials. However, based on experience at other sediment Superfund sites, EPA recommends chemical analysis of placed materials as a baseline to ensure a full understanding of any project area-specific trends for evaluation in five-year reviews. Physical parameters such as TOC and grain size will also be characterized.

4.2 Performance Monitoring

Performance monitoring evaluates sediment, riverbank soil, porewater, and/or groundwater to confirm design criteria have been achieved and the remedy is performing as designed. This is not to be confused with RAO monitoring, which measures longer-term progress toward achieving Sitewide RAOs. Details of performance monitoring are discussed below and summarized in **Table 2**. Additional performance monitoring activities may be specified during remedial design on a project area-specific basis, and alternative means and methods for performance monitoring may be developed in coordination with EPA during remedial design.

4.2.1 Dredging

Construction monitoring for dredging is expected to address short-term performance; therefore, separate performance monitoring will not be required for dredging remedies. Dredging is expected to achieve immediate risk reduction by removing the most contaminated sediments. Remaining risks across the project area will be reduced to the extent practicable through MNR. Therefore, performance monitoring for dredging will default to RAO monitoring to determine the long-term performance of dredging areas.

4.2.2 Capping

Porewater sampling will be used to monitor cap performance by measuring porewater concentrations immediately above the chemical isolation layer, and below the armor layer for armored caps. Sampling ports may need to be installed to allow reoccupation of the same sampling locations for each sampling event during five-year reviews. Porewater sampling will be conducted at time zero immediately post-construction and repeated in support of five-year reviews. Additional time steps will be considered on a project area basis to inform five-year reviews or as otherwise required.

All capping based sediment remedies will be designed to achieve the cleanup levels for project area-specific driver COCs at the appropriate location and spatial scale. Project area-specific driver COCs may include a subset of COCs listed in ROD Table 17, additional COCs listed in ROD Table 16, or other project area-specific COCs, as appropriate. Project area-specific driver COCs may be identified in the basis of design report or subsequent remedial design submittals. At least one porewater sample for each CCU within a cap footprint will be required. Porewater sampling must be conducted during periods of high groundwater upwelling (i.e., the time of year when maximum groundwater upwelling is expected for the particular capping area). Groundwater upwelling should be confirmed using direct assessment techniques such as seepage meters, potentiometric heads, etc. Depending on selected assessment techniques, conductivity, dissolved oxygen, and temperature measurements should be used as secondary lines of evidence to ensure groundwater rather than surface water is being measured for the purposes of evaluating porewater data relative to cap performance.

Bulk sediment concentrations on the surface of the cap (0 to 30 cm, or less if deposited sediment is less than 30 cm) will be monitored to assess whether any contamination on the surface of the cap is associated with sources of contamination outside the SMA or as a result of cap performance. Where deposited sediment is limited, sample location will be moved to an area within the CCU where at least 10 cm of deposition exists. Monitoring of sediment deposited on top of caps will not be used for bottom-up cap performance evaluation, but surface sediment will be sampled as a secondary line of evidence in case porewater concentrations indicate cap failure. If there is no cap breakthrough yet surface sediment concentrations exceed cleanup levels, methods to address top-down contamination of caps and overall trends in sediment concentrations will be discussed with EPA on a project area-specific basis. Bulk sediment sampling will be used to confirm depositing sediment does not exceed sediment cleanup levels and will be conducted at the same frequency as porewater sampling (at time zero, then once every five-year review period). Additional time steps will be considered on a project area-specific basis to inform the first five-year review or as otherwise required.

Cap performance monitoring will also include measuring the cap surface elevations using hydrographic surveys and/or diver surveys. The surveys will target the elevation of the top of the cap or armor layer surface and not the deposited sediment. Techniques such as probing/poling or sub bottom profilers may be used to determine thickness of deposited sediments and inform evaluation of cap elevations. Cap performance monitoring will be conducted at time zero immediately after cap construction and then once during every five-year review period. Additional time steps will be considered on a project area-specific basis to inform the first five-year review or as otherwise required. Project area-specific situations may require more or less monitoring for capping. In addition to the frequency mentioned, monitoring may also be required following a significant event such as flood, earthquake, or vessel/debris grounding.

4.3 Remedial Action Objective Monitoring

RAO monitoring evaluates whether contaminant exposures and corresponding risk are reduced to acceptable levels over the long term and also supports five-year reviews. RAO monitoring will be used to assess progress toward achieving RAOs at the Site by using long-term monitoring data collected within project areas, and data collected at the larger RAO spatial scales by EPA or PPs under agreement with EPA to conduct Sitewide monitoring in support of five-year reviews. Details of RAO monitoring for each RAO are discussed in the following sections and summarized in **Table 3.** In general, sediment remedies will be designed to achieve the cleanup levels specified in ROD Table 17 over the long term at the appropriate spatial scales. Sediment cleanup levels are expected to be achieved throughout the upper 30 cm of sediment. Groundwater cleanup levels are expected to be met within the upper 30 cm of porewater. The upper 30 cm depth interval is consistent with the surface sediment interval discussed in ROD Section 6.5.2.

RAO monitoring will be performed to measure achievement of cleanup levels. Additional remedial measures may be required if it is determined that the remedy is not functioning as intended. Sediment, porewater/groundwater, fish/shellfish tissue, and surface water data will be collected over appropriate spatial scales to monitor progress toward achieving RAOs 1 and 5 (sediment), RAOs 2 and 6 (biota), RAOs 3 and 7 (surface water), RAOs 4 and 8 (groundwater), and RAO 9 (riverbanks) through comparison with preliminary remediation goals (PRGs) for each RAO. The feasibility study (FS) PRGs (see FS Tables 2.2-4 through 2.2-12) will be used for RAO monitoring so that COCs that are relevant to each RAO are evaluated against a remedial goal specific to the human health or ecological RAO over the appropriate spatial scale. Data collected under project area long-term monitoring will be aggregated for evaluating achievement of RAOs at the Site. If possible, efforts will be made to collect project area long-term monitoring data to be integrated in RAO monitoring during the same general time frame (i.e., on a five-year review schedule), under similar river stage conditions, and according to similar means and methods as RAO monitoring data collected Sitewide for five-year reviews. Monitoring of MNR and ENR areas within project areas may be conducted at a finer spatial resolution than the coarser spatial resolution that may be applied to monitoring on a Sitewide basis. In addition to the frequency mentioned, monitoring may also be required following a significant event such as flood, earthquake, or vessel/debris grounding. The appropriate spatial scales for project area long-term monitoring will be developed in PPs PAMPs in consultation with EPA and the TCT.

4.3.1 RAOs 1 and 5 – Sediment

The human health risk-based RAO 1 for sediment will be evaluated against the PRGs in FS Table 2.2-4 in surface sediment 0 to 30 cm below mudline (bml). Surface sediment samples will be analyzed for the COCs listed in FS Table 2.2-4 and evaluated by calculating the surface area - weighted average concentration (SWAC) over the 0.5 rolling river mile on each side of the river in shallow and intermediate regions, and beach exposure areas where each discrete beach is evaluated as one exposure area. Discrete beach exposure areas 0.5 rolling river mile on each side outside the navigation channel are considered an appropriate spatial scale for RAO 1 monitoring because of the risk evaluations presented in the baseline human health risk assessment (BHHRA) and the FS (see **Table 3** for additional details). Baseline beach soil chemistry data should also be collected in project areas with beaches.

The ecological RAO 5 for sediment will be evaluated against the PRGs in FS Table 2.2-8 in surface sediment 0 to 30 cm bml. An individual surface sediment sample will be collected within each stratified random sampling (SRS) grid polygon and will be analyzed for the COCs listed in FS Table 2.2-8. The SRS grid developed for 2018 to 2019 baseline sampling will be used for RAO 5 monitoring on a Sitewide basis.

RAO monitoring of surface sediment will duplicate the 2018 to 2019 baseline surface sediment sampling efforts by collecting individual samples within each SRS grid polygon. The required number of surface sediment samples was developed based on an evaluation of expected Sitewide trends in surface sediment concentrations associated with the selected remedy, the variability in the existing surface sediment data set, and the spatial scale of the monitoring program. A statistical evaluation will be performed to estimate the trend in sediment COC concentrations and to estimate the uncertainty in these estimates based on the statistical power of the analysis relative to the sample numbers. The data may also be used to support an equivalency analysis (see RDGC Section 1.4, remedial design principle 5). Natural recovery will be evaluated on a Sitewide basis through long-term RAO monitoring that includes sediment characterization both inside and outside the SMAs, and additional lines of evidence such as bathymetry and sediment trap data. Sediment trap data may be used to characterize sediment movement into, within, and out of the Site, and can be evaluated over time to assess changes in contaminated sediment load associated with implementation of the remedy. However, sediment traps do not account for cyclical erosion or deposition.

Long-term monitoring data within project areas may be collected at a finer spatial resolution than the Sitewide SRS grid. For some project areas, if the PRGs for RAO 5 are exceeded based on sediment concentrations, benthic risk may need to be evaluated using benthic toxicity tests post-construction as a baseline and continued for each five-year review. In addition to the contaminants with RAO 5 PRGs, benthic toxicity should be evaluated for all relevant project area contaminants, including ROD Table 16 contaminants. For some project areas, if the PRGs for RAO 5 are exceeded based on sediment concentrations, benthic risk posed by Table 16 and 17 COCs may best be evaluated using benthic toxicity tests post-construction as a baseline and continued for each five-year review.

4.3.2 RAOs 2 and 6 – Biota

The human health RAO 2 for biota consumption will be evaluated against the sediment PRGs in FS Table 2.2-5 in surface sediment 0 to 30 cm bml. Surface sediment samples will be analyzed for the COCs listed in FS Table 2.2-5 and evaluated by calculating the SWAC over 1 rolling river mile on one side from river centerline. One rolling river mile on one side is considered a reasonable spatial scale for RAO 2 monitoring because smallmouth bass tend to stay on one side and shellfish consumption was also evaluated per river mile on each side. Human health risk-based tissue targets were also determined in the FS for fish/shellfish tissue using the food-web model. Therefore, resident fish/shellfish tissue will also be collected for evaluation against the biota tissue target levels in FS Table 2.2-5 over the relevant exposure area based on species. These target levels of chemicals in fish/shellfish tissue are not PRGs or cleanup levels but will be monitored to inform fish advisories and evaluate progress toward achieving RAOs.

The ecological RAO 6 for biota (predators) will be evaluated against the sediment PRGs in FS Table 2.2-9 in surface sediment 0 to 30 cm bml. Surface sediment samples will be analyzed for the COCs listed in FS Table 2.2-9 and evaluated by calculating the SWAC over 1 rolling river mile. One river mile on both sides of the river is an appropriate spatial scale for RAO 6 monitoring because smallmouth bass tend to stay on one side of the river but osprey may forage on both sides of the river, so the baseline ecological risk assessment (BERA) evaluated osprey risks on a 1-mile basis for both sides of the river.

Sediment samples for RAOs 2 and 6 will be collected in an identical manner as discussed in **Section 4.3.1** for RAOs 1 and 5. Additionally, the 2018 to 2019 baseline monitoring program fish tissue sampling and analysis efforts are anticipated to be duplicated to monitor reductions in tissue concentrations and act as an additional line of evidence to evaluate progress toward achieving RAOs 2 and 6. Statistical evaluations will be performed to estimate the trend in sediment and tissue COC concentrations and to estimate the uncertainty in these estimates based on the statistical power of the analysis relative to the sample numbers.

The sediment data collected for project area long-term monitoring will be used to complement and inform RAOs 2 and 6 monitoring, and will also be used to evaluate project area trends and potential follow-up needs in the five-year reviews.

4.3.3 RAOs 3 and 7 – Surface Water

The human health RAO 3 for surface water will be evaluated against the surface water PRGs in FS Table 2.2-6 using the same surface water sampling transect stations as the baseline monitoring program. Surface water samples will be analyzed for the COCs listed in FS Table 2.2-6 and consistent with the BHHRA, the data from the surface water sampling transects will be evaluated individually and combined for Sitewide analysis.

The ecological RAO 7 for surface water will be evaluated against the surface water PRGs in FS Table 2.2-10 using the same surface water sampling transect stations as the baseline monitoring program. Surface water samples will be analyzed for the COCs listed in FS Table 2.2-10 and will be evaluated per surface water sampling transect. The BERA evaluated surface water data on a sample-by-sample basis to characterize risk for benthic invertebrates; however, for fish, evaluation of transect single-point XAD and peristaltic samples were used to provide a larger dataset for estimating fish surface water exposure point concentrations. For the purposes of RAO 7 monitoring, the spatial scale will be each surface water sampling transect.

Surface water samples will be monitored during each five-year review period. Sampling events are anticipated to capture at a minimum early fall low flow conditions and winter high flow conditions. The sampling is not designed to capture extreme events but rather seasonal low flow (less than 20,000 cubic feet per second [cfs]) and high flow (greater than 50,000 cfs) conditions that occur on an annual basis. In addition to regular surface water monitoring, an additional round (or rounds) of surface water sampling may be required in the event of an abnormally high flow event (e.g., 100-year flood event).

Surface water data within project areas will also be collected as near-bottom surface water samples collected within the surface water approximately 30 cm above the mudline will be analyzed for the COCs listed in FS Table 2.2-6 and FS Table 2.2-10 for RAOs 3 and 7, respectively. The BERA evaluated surface water data on a sample-by-sample basis to characterize risk for benthic invertebrates, so RAO 7 should be evaluated on a point-by-point basis within project areas. Since Sitewide monitoring of RAOs 3 and 7 will be based on surface water sampling transects and not on near-bottom surface water samples, project area surface water data may not be usable for Sitewide RAO monitoring purposes. Colocated near-bottom surface water and porewater samples are recommended to evaluate project area-specific contributions to Sitewide surface water concentrations. Statistical evaluations will be performed to estimate the trend in surface water COC concentrations.

4.3.4 RAOs 4 and 8 – Groundwater/Porewater

The human health RAO 4 for groundwater will be evaluated against the groundwater PRGs in FS Table 2.2-7 by collecting porewater samples in areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination identified during the RI and/or remedial design at 0 to 30 cm bml. If there are cap monitoring ports the 30 cm below the armor layer will be monitored to ensure evaluation of porewater in fine material likely to be occupied by benthic organisms and to avoid sampling surface water within the armor layer interstices, unless a substantial amount of sediment has deposited on top of the cap. Porewater samples for RAO 4 will be analyzed for the COCs listed in FS Table 2.2-7. A reduced list of analytes may be considered for project area long-term monitoring but all COCs on FS Table 2.2-7 will need to be monitored for Sitewide RAO monitoring. Based on the BHHRA, it is appropriate to use each upwelling zone where a groundwater seep is located as a spatial scale for RAO 4 monitoring and multiple samples collected within areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination will be averaged.

The ecological RAO 8 for groundwater will be evaluated against the porewater PRGs in FS Table 2.2-11 by collecting at least one porewater sample per acre in areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination identified during the RI and/or remedial design 0 to 30 cm bml if there is no cap monitoring port. For areas with cap monitoring ports the 30 cm below the armor layer will be monitored. Porewater samples for RAO 8 will be analyzed for the COCs listed in FS Table 2.2-11. The BERA evaluated transition zone water on a sample-by-sample basis to characterize risk for benthic invertebrates so point concentrations within areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination will be used as the spatial scale for RAO 8 monitoring.

A statistical evaluation will be performed to estimate the trend in porewater and surface water COC concentrations over time to assess progress towards achieving RAOs 4 and 8. Porewater sampling for RAOs 4 and 8 will be conducted at the time of year when maximum groundwater upwelling is expected. In cases where contaminants without groundwater cleanup levels may pose a recontamination risk, monitoring data will be compared to RAO 3 PRGs for informational purposes.

Since the BERA evaluated transition zone water[5] on a sample-by-sample basis to characterize risk for benthic invertebrates, point concentrations in areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination identified during the RI and/or remedial design should be used as the spatial scale for RAO 8 monitoring. Porewater sampling for RAOs 4 and 8 will be conducted at the time of year when maximum groundwater upwelling is expected. Groundwater upwelling should be confirmed using direct assessment techniques such as seepage meters, potentiometric heads, etc. Depending on selected assessment techniques, conductivity, dissolved oxygen, and temperature measurements should be used as secondary lines of evidence to ensure groundwater rather than surface water is being measured for the purposes of evaluating porewater data relative to cap performance. A statistical evaluation will be performed to estimate the trend in porewater COC concentrations over time to assess progress towards achieving RAOs 4 and 8. If possible, porewater samples within project areas will be colocated with the near-bottom surface water samples discussed in **Section 4.3.3** to evaluate potential porewater-surface water interactions. The porewater data collected for project area long-term monitoring will be used to complement and inform RAO monitoring and will also be used to evaluate project area-specific trends and potential follow up needs in the five-year reviews.

4.3.5 RAO 9 – Riverbanks

RAO 9 is the human health and ecological RAO for riverbanks to be evaluated against PRGs in FS Table 2.2-12 in riverbank soil 0 to 30 cm below ground surface. The riverbank soil data collected for project area long-term monitoring of riverbanks will be used to complement and inform Sitewide RAO monitoring. Further details of riverbank monitoring, including the appropriate spatial scales, will be determined based on future discussions with the TCT and PPs during the development of project area PAMPs.

[5] Transition zone water is the zone where surface water and groundwater/porewater mix. This term is used here to be consistent with the BERA evaluation but porewater monitoring will be conducted during periods of high upwelling to measure freely dissolved concentrations in porewater and avoid impacts from surface water intrusion.

4.3.5 RAO 9 – Riverbanks

RAO 9 is the human health and ecological RAO for riverbanks to be evaluated against PRGs in FS Table 2.2-12 in riverbank soil 0 to 30 cm below ground surface. The riverbank soil data collected for project area long-term monitoring of riverbanks will be used to complement and inform Sitewide RAO monitoring. Further details of riverbank monitoring, including the appropriate spatial scales, will be determined based on future discussions with the TCT and PPs during the development of project area PAMPs.

Tables

Table 1: Construction Monitoring

What: Evaluates whether the remedy was constructed to applicable design criteria, plans, and specifications
When: Occurs during and immediately post-construction
Where: Within project area
Who: PP under agreement with EPA

Technology	Monitoring Medium/Metric	EPA Monitoring Expectations[1]	Criteria	Spatial Scale
Capping	Isolation Layer Chemistry	Ex situ testing of import cap materials prior to placement (e.g., one sample per 500 cubic yards of material per Section 5.1.7 of the RDGC or as otherwise approved by EPA) and/or testing of placed cap materials	Below applicable Table 17 sediment CULs[2]	CCU
	Cap Thickness and Layer Mixing	Physical and hydrographic surveys (e.g., small-diameter sediment cores, catch pans or stakes, sediment profile image surveys, bucket surveys, dive surveys, mass balance approaches, bathymetric surveys)	Meets design specifications, including minimum cap thickness	CCU
	Armor Layer Thickness	Physical and hydrographic surveys (e.g., multibeam bathymetric surveys, probing/poling, diver surveys)	Meets design specifications	CCU
Dredging	Dredge Prism Elevation	Pre- and post-construction physical and hydrographic surveys (e.g., multibeam bathymetric surveys, single beam bathymetric surveys)	Meets design specifications, including minimum removal thickness	DCU
	Dredge Cover/Backfill Thickness [3]	Physical and hydrographic surveys (e.g., multibeam bathymetric surveys, single beam bathymetric surveys, diver surveys)	Meets design specifications, including minimum cover thickness	DCU
	Dredge Cover/Backfill Chemistry	Ex-situ testing of import cap materials prior to placement (e.g., one sample per 500 cubic yards of material per Section 5.1.7 of RDGC or as otherwise approved by EPA) and/or testing of placed materials	Below applicable Table 17 sediment CULs[2]	Dredge Certification Unit
	Post-Dredge Sediment Concentrations[4]	The post-dredge surface of DCUs will be cored before placement of the residual management layer/cover. If no missed inventory (i.e., sediment concentrations exceeding RALs/PTW thresholds) is identified below the generated residuals layer, then dredge closeout will be approved and the operationally defined generated residuals layer will be compared to the residual management value. Details of this method are defined in RDGC Appendix B, Topic 3 and summarized in the notes below on Gasco DMU closeout verification procedures. Alternative techniques may be developed in coordination with EPA.[5]	Operationally defined generated residuals layer: Residual management value[6] Below generated residuals layer: Below Table 21 RALs and PTW thresholds[2]	DCU
ENR	ENR Layer Chemistry	Ex situ testing of import materials prior to placement (e.g., one sample per 500 cubic yards of material per Section 5.1.7 of the RDGC or as otherwise approved by EPA) and/or testing of placed materials.	Below applicable Table 17 sediment CULs	ENR Certification Unit
	ENR Layer Thickness	Physical and hydrographic surveys (e.g., small-diameter sediment cores, sediment profile image surveys, dive surveys, hydrographic surveys)	Meets design specifications	ENR Certification Unit
Riverbank Remedy[7]	TBD	TBD	TBD	TBD

Notes:
BODR – basis of design report
CCU – cap certification unit
COC – contaminant of concern
CUL – cleanup level
DCU – dredge certification unit
DMU – dredge management unit
ENR – enhanced natural recovery
EPA – U.S. Environmental Protection Agency
MNR – monitored natural recovery
PP – performing party
PWT – principal threat waste
RAO – remedial action objective
RAL – remedial action level
RDGC – Remedial Design Guidelines and Considerations
ROD – record of decision
TBD – to be determined
TCT – Technical Coordination Team

- The table focuses on construction monitoring of active remediation technologies and ENR. MNR will be evaluated via RAO monitoring, and water quality monitoring during construction will be addressed separately in project area-specific construction quality assurance/quality control plans.
- Tolerances for achieving requirements will depend on monitoring means and methods. This will be determined during remedial design based on industry standards.
- Additional construction monitoring activities may be specified during remedial design on a project area-specific basis.
- Long-term monitoring of dredging effectiveness will be addressed by RAO monitoring (see Table 3) during FYRs.
- CCU definition: Maximum 1-acre cap area used to certify cap construction. The actual size of the certification unit will be determined on a project area-specific basis during remedial design.
- DCU definition: A subunit of DMUs (maximum 1 acre) that will be used for closeout certification.

[1] Alternative means and methods may be determined in coordination with EPA during remedial design based on project area-specific considerations.
[2] Project area-specific contaminants may be identified in the BODR or subsequent remedial design submittals. Project area-specific contaminants may include a subset of COCs listed on Table 17, additional contaminants found on Table 16, or other site-specific contaminants, as appropriate.
[3] Consistent with ROD Section 14.2.9.2, "Residual management layers will be placed as soon as is practicable following dredging within the prism and surrounding area and are assumed to be 12 inches in thickness." The term dredge cover is used synonymously with the residual management layer described in the ROD.
[4] EPA supports using an operationally defined generated residuals layer thickness for convenience and consistency during project planning, but the thickness of the generated residuals layer will be confirmed based on dredge confirmation core observations.
[5] Some universal requirements for dredge confirmation sampling include:

  - Two consecutive intervals with concentrations below RALs will be needed for EPA approval of dredging closeout.
  - Confirmation sampling will occur relatively quickly for each dredge certification unit (i.e., within days/weeks), and closeout of dredge certification units (i.e., residual management layer or cap placement) will be required at the end of each dredging season.

[6] The residual management value is calculated using 15% of the concentration in the generated residuals layer in the bottom 2 inches of the residual management layer, as recommended by the U.S. Army Engineer Research and Development Center memorandum *Review and Recommendations on Dredge Releases and Residuals Calculations from the Portland Harbor Draft Feasibility Study*, dated May 24, 2013. PPs will develop the residual management values applicable to their project areas in coordination with EPA.
[7] Placeholder pending further discussions with the TCT and project area-specific discussions with PPs.

Gasco post-dredge DMU closeout verification summary (refer to EPA's RDGC, Appendix B, Topic 3 for additional details):

  - Immediately after verification that dredge prism elevations/thicknesses have been achieved in a DMU, five cores per acre with a minimum of two cores per DMU will be collected.
  - Each core will be visually observed for the presence of NAPL, if applicable.
  - The top 6-inch interval will represent the operationally defined 6-inch residual layer.
  - Samples will be collected at 6-inch intervals from each core below the operationally defined residuals layer. Samples from each interval from each core will be composited into a single sample from each interval in the DMU if the samples do not contain visible observations of tar. If NAPL or tar is observed discrete samples will be required.
  - Samples from each operationally defined 6-inch residuals layer interval from each core will be composited into a single sample in the DMU and submitted for laboratory analysis. Concentrations in the residuals layer will be compared to the residual management value. If an exceedance is identified, archived discrete samples from the top 6-inch interval will be analyzed and additional measures, such as increasing cover thickness or incorporation of reactive amendments to the cover, will be determined.
  - Starting from the sample below the operationally defined 6-inch residuals layer interval, successively deeper composite samples will be analyzed until there are no RAL exceedances.
  - If the first two 6-inch intervals below the residuals layer interval have concentrations below RALs, EPA will approve dredging closeout in the DMU. If the first two 6-inch intervals exceed RALs or PTW thresholds the need for additional measures will be determined in coordination with EPA.
  - Periodic monitoring of the generated residuals layer thickness will be conducted to confirm that the operational definition is appropriate.

Table 2: Performance Monitoring

What: Evaluates if the remedy is performing as designed
When: Occurs periodically post-construction
Where: Within project area
Who: PP under agreement with EPA

Remedial Technology	Performance Objective	Monitoring Medium/Metric	Monitoring Location	COCs[1]	Criteria	Spatial Scale	Frequency[2,]
Capping	Isolate contaminated porewater	Porewater Concentration	Immediately above the chemical isolation layer and below the armor layer (conducted during periods of high groundwater discharge)[3]	Project area-specific driver COCs	CULs	CCU	t=0; then 1 time per FYR
	Cap performance/ top down contamination assessment	Post-Capping Surface Sediment[4]	0–30 cm surface sediment, or less if deposited sediment is less than 30 cm	Project area-specific driver COCs	CULs	CCU	t=0; then 1 time per FYR
	Isolate contaminated sediment	Cap Elevation	Top of cap surface	Physical and hydrographic surveys (e.g., multibeam bathymetry and diver surveys)	Design specifications	CCU	t=0; then 1 time per FYR
	Armor layer integrity	Armor Layer Elevation/Thickness	Top of armor layer	Physical and hydrographic surveys (e.g., diver surveys, probing/poling)	Design specifications	CCU	t=0; then 1 time per FYR

Notes:

- CCU definition: Maximum 1-acre cap area used to certify cap construction. The actual size of the certification unit will be determined on a project area-specific basis during remedial design.
- DCU definition: A subunit of DMUs (maximum 1 acre) that will be used for closeout certification.

[1] Project area-specific driver COCs may include a subset of contaminants listed on ROD Table 17, additional contaminants found on ROD Table 16, or other site-specific contaminants, as appropriate. Project area-specific driver COCs may be identified in the BODR or subsequent remedial design submittals.
[2] t=0 is defined as immediately post-construction. Additional time steps will be considered on a project area-specific basis to inform the first FYR or as otherwise required. Project area-specific situations may require more or less monitoring for capping. In addition to the frequency mentioned, monitoring may also be required following a significant event such as flood, earthquake, or vessel/debris grounding.
[3] Ideally, the porewater sample will be collected in the top 0–30 cm of the chemical isolation layer unless additional fine-grained layers, such as a geotechnical filter layer, are included above the chemical isolation layer. A monitoring port may be required in areas of deposition to best represent cap function in protection of the BAZ, and avoid possible interferences of deposited sediment chemistry in the BAZ itself. Porewater sampling must be conducted during the time of year when maximum groundwater upwelling is expected for the particular SMA. Depending on selected assessment techniques, conductivity, dissolved oxygen, and temperature measurements may be used as lines of evidence to ensure groundwater rather than surface water is being measured for the purposes of evaluating porewater data relative to cap performance.
[4] Monitoring of sediment deposited on top of caps will not be used for bottom-up cap performance evaluation, but surface sediment will be sampled as a secondary line of evidence in case porewater concentrations indicate cap failure. If there is no cap breakthrough yet surface sediment concentrations exceed CULs, methods to address top-down contamination of caps will be discussed with EPA on a project area-specific basis. Sampling may be conducted via the project area RAO monitoring under Table 3 below; however, additional surface sediment sampling in capped areas may be required on a project area-specific basis. Where deposited sediment is limited, sample location will be moved to an area within the CCU where at least 10 cm of deposition exists.

BAZ – biologically active zone
BODR – basis of design report
CCU – cap certification unitCOC – contaminant of concern
CUL – cleanup level
DMU – dredge management unit
EPA – U.S. Environmental Protection Agency
FYR – five-year review
PP – performing party
RAL – remedial action level
RAO – remedial action objective
SMA – sediment management area
t – time

Table 3: RAO Monitoring

What: Evaluates whether RAOs are being achieved
When: Occurs periodically post-construction (e.g., to support FYRs)[1]
Where: Sitewide and project areas, including MNR and ENR areas
Who: PP under agreement with EPA

RAO	Receptor	Monitoring Medium	Performance Standards	Spatial Scale	COCs	Remedial Goal
1	Human	Sediment	0–30 cm	Beach exposure areas and the 0.5 rolling river mile on each side in shallow and intermediate regions	COCs in FS Table 2.2-4 RAO 1 PRG Derivation	PRGs
2	Human	Sediment[2]	0–30 cm	1 rolling river mile on one side from river centerline	COCs in FS Table 2.2-5 RAO 2 PRG Derivation	PRGs
2	Human	Fish/Shellfish Tissue	Resident fish/shellfish	Relevant exposure area based on species	COCs in FS Table 2.2-5 RAO 2 PRG Derivation	Target levels
3	Human	Surface Water	Sitewide: per transect station Project area: near-bottom surface water[3] (aggregated Sitewide)	Per transect station/near-bottom samples to the extent available from project areas	COCs in FS Table 2.2-6 RAO 3 PRG Derivation	PRGs
4	Human	Groundwater/Porewater	In areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination identified during the RI and/or remedial design at 30 cm bml if there is no port, and 30 cm below armor layer if there is a port[4]	Areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination[3]	COCs in FS Table 2.2-7 RAO 4 PRG Derivation	PRGs
5	Ecological	Sediment	0–30 cm	Individual sample within stratified random sampling grid polygon	COCs in FS Table 2.2-8 RAO 5 PRG Derivation	PRGs[5]
6	Ecological	Sediment	0–30 cm	1 rolling river mile on both sides of the river	COCs in FS Table 2.2-9 RAO 6 PRG Derivation	PRGs
7	Ecological	Surface Water	Sitewide: per transect station Project area: near bottom surface water[3] (aggregated Sitewide)	Per transect station/near-bottom samples to the extent available from project areas	COCs in FS Table 2.2-10 RAO 7 PRG Derivation	PRGs
8	Ecological	Groundwater/Porewater	In areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination identified during RI and/or remedial design at 30 cm bml if there is no port, and 30 cm below armor layer if there is a port	Areas of high groundwater discharge, groundwater plume expression, and/or buried sediment contamination [3]	COCs in FS Table 2.2-11 RAO 8 PRG Derivation	PRGs
9	Human and Ecological	Riverbank Soil	0–30 cm	To be determined[7]	COCs in FS Table 2.2-12 RAO 9 PRG Derivation	PRGs

Notes:
BERA – baseline ecological risk assessment
BHHRA – baseline human health risk assessment
bml – below mudline
cm – centimeter
COC – contaminant of concern
ENR – enhanced natural recovery
EPA – U.S. Environmental Protection Agency
EPC – exposure point concentration
FS – feasibility study
FYR – five-year review
HQ – hazard quotient
km – kilometer
MNR – monitored natural recovery
PP – performing party
PRG – preliminary remediation goal
RAO – remedial action objective
ROD – record of decision

SWAC – surface area-weighted average concentration
TCT – Technical Coordination Team
TRV – toxicity reference value
TZW – transition zone water
UCL – upper confidence limit

[1] Additional time steps will be considered on a project area-specific basis to inform the first FYR or as otherwise required. In addition to the frequency mentioned, monitoring may also be required following a significant event such as flood, earthquake, vessel/debris grounding, etc.
[2] Sediment-based PRGs from FS Table 2.2-5 will be used to quantitatively measure progress towards achievement of RAO 2. Human health risk-based tissue targets were also determined in the FS for fish/shellfish tissue using the food-web model. These levels of chemicals in fish/shellfish tissue are not cleanup levels but will be monitored to inform fish advisories and evaluate progress toward achieving RAOs.
[3] Surface water samples will be collected approximately 30 cm above mudline.
[4] Porewater sampling must be conducted during the time of year when maximum groundwater upwelling is expected to best evaluate whether RAOs 4 and 8 have been achieved. Porewater data collected during cap performance monitoring may be used, as applicable, to complement and inform RAO monitoring.
[5] For some project areas, if the PRGs for RAO 5 are exceeded based on sediment concentrations, benthic risk may need to be evaluated using benthic toxicity tests post-construction as a baseline and continued for each FYR. In any case, benthic toxicity should be evaluated for all relevant project area contaminants, including ROD Table 16 contaminants, in addition to the contaminants with RAO 5 PRGs per ROD Chapters 8 and 14.
[6] Placeholder pending further discussions with the TCT and project area-specific discussions with PPs.

Appendix D

Guidance for Riverbank Characterizations and Evaluations

Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site

Prepared by

U.S. Environmental Protection Agency Region 10

December 23, 2019

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Abbreviations and Acronyms

µg/kg	micrograms per kilogram
ASAOC	administrative settlement agreement and order on consent
ARAR	applicable or relevant and appropriate requirement
BANCS	Bank Assessment for Non-Point Source Consequences of Sediment
BEHI	bank erosion hazard index
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CRD	Columbia River Datum
CSM	conceptual site model
CUL	cleanup level
DEQ	Oregon Department of Environmental Quality
DQO	data quality objective
ECSI	Environmental Cleanup Site Information database
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
IC	institutional control
ISM	incremental sampling methodology
ITRC	Interstate Technology Regulatory Council
JSCS	Joint Source Control Strategy
MHW	mean high water
MLW	mean low water
MNR	monitored natural recovery
MOU	memorandum of understanding
NAPL	nonaqueous phase liquid
NAVD 88	North American Vertical Datum of 1988
NBS	near-bank stress
NGVD 29	National Geodetic Vertical Datum of 1929
NRC	not reliably contained
OAR	Oregon Administrative Rules
OHW	ordinary high water
PHSS	Portland Harbor Superfund Site
PTW	principal threat waste
QAPP	quality assurance project plan
RAL	remedial action level
RAO	remedial action objective
RM	river mile
ROD	record of decision
SAP	sampling and analysis plan
SCD	source control decision
SCE	source control evaluation
SCM	source control measure
SLV	screening level value
SMA	sediment management area
USACE	U.S. Army Corps of Engineers

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1.0 Introduction and Scope

This document provides guidance and procedures developed by the U.S. Environmental Protection Agency (EPA) for evaluating river banks located within the Portland Harbor Superfund Site (PHSS). The guidance categorizes river banks, provides roles for EPA and Oregon Department of Environmental Quality (DEQ), and is to be used to guide the source control and remedial design process for river banks within PHSS. Within this guidance, specific terms and phrases are adapted and used for various technical aspects of the Superfund cleanup program for PHSS. Selected terms are included in the glossary of **Appendix A**, with definitions adapted primarily from PHSS record of decision (ROD) Section 17 (EPA 2017).

The PHSS ROD presents the Selected Remedy (EPA 2017) that addresses all contaminated media and complete exposure pathways posing unacceptable risk to human health or the environment, including sediment, biota, surface water, groundwater, and river banks. The Selected Remedy utilizes a combination of technologies, including capping, dredging/excavating, in situ and ex situ treatment, enhanced natural recovery (ENR), monitored natural recovery (MNR), and institutional controls (ICs) to achieve the remedial action objectives (RAOs). Contaminated river banks will be remediated through this cleanup strategy to achieve the cleanup objectives where they are contiguous with in-river contamination or where they pose a risk of recontamination to the Selected Remedy. As stated throughout the ROD, integral to the Selected Remedy is the goal to achieve cleanup levels (CULs) and remedial action objectives within a reasonable time frame. The RAOs of the Selected Remedy address all areas where contaminant concentrations exceed the applicable CULs.

1.1 Scope and Applicability

EPA developed this guidance for the characterization, evaluation, and cleanup of river bank soil/sediment to be consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements of the PHSS ROD (EPA 2017) and with the DEQ upland source control program, as guided by the Joint Source Control Strategy (JSCS) (DEQ and EPA 2005). The scope and roles described herein conform to the agreements in the 2001 memorandum of understanding (MOU) between EPA, DEQ, natural resource trustees, and the Native American tribes that have an interest in the affected resources (EPA 2001). The MOU establishes the roles to effectively manage the cleanup activities in a manner consistent with the requirements of CERCLA and achieve the cleanup goals of the PHSS ROD. Per the MOU, DEQ is the lead agency for addressing contamination in the upland portions of PHSS, and EPA is the lead agency for the in-river portion of PHSS. The in-river portion of PHSS is inclusive of sediment, biota, surface water, and river banks (EPA 2017).

This river bank guidance describes the process for river bank characterizations and erodibility assessments and provides a cleanup implementation decision process to achieve remedial goals and be protective of all components of the Selected Remedy. Therefore, the procedures and processes described are applicable to and recommended for all activity at river banks within the PHSS area, which extends from river mile (RM) 1.9 (upriver end of the Port of Portland's Terminal 5) to RM 11.8 (near the Broadway Bridge), as described in ROD Part 2, Section 1. The applicability of the guidance has some flexibility to accommodate the differences in administrative procedures between the federal (CERCLA) and state programs and to be consistent with the 2001 MOU. Throughout the guidance, reference is made to requirements and objectives of the Selected Remedy, with the intent to inform and guide—but not prescribe—methods and to instill awareness that implementation of the Selected Remedy is to balance cleanup with the habitat obligations identified in the ROD.

Planning, evaluating, or designing river bank work at PHSS, either for remedial action per the ROD or as a result of shoreline redevelopment or habitat improvement projects, should be managed and conducted in accordance with this river bank guidance. Contaminated river banks identified in the ROD and river banks adjacent to sediment management areas (SMAs) will be managed as ROD river banks within the EPA CERCLA authority, whereas river banks not identified in the ROD or not adjacent to SMAs will be managed as JSCS river banks within the DEQ upland source control program authority. Application of this guidance to the different categories of river banks at PHSS is described in the following section.

1.2 River Bank Categories

The scope of this guidance is consistent with the ROD and addresses river banks as contiguous geomorphic and/or engineered features. Per Section 14.2.5 of the ROD, the river bank region is defined as "areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas" (EPA 2017). The shallow region is defined in ROD Section 14.2.4 as the area shoreward of the river bed elevation of approximately minus 2 feet (−2 feet) Columbia River Datum (CRD). Relative to application of this guidance, the extent of a river bank is not limited to a property boundary. Therefore, characterization and implementation of a cleanup decision is based upon the extent of contamination.

As developed for this guidance, the cleanup of river banks within PHSS is managed with federal and/or state authorities to address river banks in the following three categories:

- ROD river banks
- River banks pending characterization
- JSCS river banks

1.2.1 ROD River Banks

ROD river banks comprise those contaminated river banks listed in ROD Section 6.6.6 and shown on ROD Figures 9 and 30 (see **Figure 1** and **Table 2**). The ROD river banks and river banks pending characterization (see **Table 3**) comprise contaminated river banks that are to be addressed using CERCLA authority and similar remedial technologies as the adjacent/nearby contaminated SMAs when it is determined those river banks should be remediated in conjunction with the sediment action or where they pose a risk of recontamination to the Selected Remedy (ROD Section 14.2.9.5). When not planned for remediation in conjunction with an SMA, the cleanup of ROD river banks is to follow CERCLA requirements to achieve the RAOs of the Selected Remedy as prescribed in the PHSS ROD. Per PHSS ROD Section 15.2, the CERCLA process requires that remedial action be performed per the Selected Remedy to meet applicable or relevant and appropriate requirements (ARARs), which include regulatory requirements of the Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act. Compliance with these requirements and meeting the habitat obligations of the Selected Remedy are best achieved through early coordination/consultation with natural resource agencies during the remedial design.

ROD river banks are addressed through the EPA federal authority; however, the state may undertake actions at river banks that are the subject of the ROD (i.e., ROD river banks or river banks pending characterization) to expedite source control of contaminated upland areas as necessary and as described in ROD Sections 14.2 and 14.2.5 (EPA 2017). State-led actions on ROD river banks are to be determined on a site-specific basis. Those state-led actions will be consistent with the Selected Remedy and are expected to meet or be more stringent than CERCLA remedial requirements (ROD Section 5). Because the achievement of CULs identified in the Selected Remedy (see **Table 1**) relies in part upon timely and successful completion of upland source control actions, EPA retains the discretion to use its federal authorities to complete actions at any river bank and/or uplands within PHSS (EPA 2017).

1.2.2 River Banks Pending Characterization

Figure 1 includes properties with river banks adjacent to an SMA, which might not have been individually identified in the ROD, and that have information obtained from the DEQ's Environmental Cleanup Site Information (ECSI) database. These river banks are identified in **Table 3** and referred to as pending characterization and/or delineation of the adjacent SMAs. As such, they are included within the management strategy for the Selected Remedy based upon the rationale in ROD Section 14.2.5 that states the following: "*River banks are defined as areas from the top of the bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas. Remediation of contaminated river banks is included in the Selected Remedy where it is determined that it should be conducted in conjunction with the in-river actions and to protect the remedy. Other river banks may be included in the remedial action if contamination contiguous with contaminated river sediment is found during remedial design sampling*" (EPA 2017).

The categorization of river banks and the SMA footprints might change after remedial design and other post-ROD data are evaluated. If SMA delineation identifies contamination contiguous with the river bank, then the river bank is subject to the same requirements as the ROD river banks described above.

1.2.3 JSCS River Banks

The JSCS river banks category relates to river bank areas managed with state (DEQ) authority that, at this pre-design phase, were not identified as being contiguous with or adjacent to SMAs. The extent and specific delineations (footprints) of SMAs might change after post-ROD data are evaluated. JSCS river banks not anticipated for remedial design of an active remedy component (i.e., dredging/capping, excavating, and placement of clean sediment for ENR) remain under state purview and follow this river bank guidance and the JSCS for assessment, characterization, and potential future action, as needed, to prevent recontamination of the Selected Remedy.

The JSCS was developed to support the MOU, with the goal to identify, evaluate, and control upland sources of contamination, including river banks, that might impact the Willamette River. DEQ is expected to use its state authority within Oregon Administrative Rules (OAR) 340-122-0010 to 0140 to address these upland sources and river banks, as described in the JSCS (DEQ and EPA 2005). Source control for river banks is an integral component of the PHSS Selected Remedy and is necessary for the long-term effectiveness of MNR. Per the MOU (EPA 2001), upland source control is conducted with DEQ oversight. Characterization, evaluations, source control measures (SCMs), and source control decisions (SCDs) at JSCS river banks are guided by the JSCS. Screening following the weight-of-evidence approach described in Section 5.1.2 of the JSCS (DEQ and EPA 2005), chemical and physical characterization, and applicable SCMs are necessary before implementation of the PHSS in-river remedy to reduce potential recontamination of the in-river remedy. Post-ROD distinctions are made in this guidance to note that:

- The CULs provided by ROD Table 17 and listed in this guidance in **Table 1** replace and supersede JSCS screening level values (SLVs) for the specific chemicals and media listed.
- As a requirement of the upland source control program, specified in JSCS Section 1.1, "*upland source control decisions will need to be reviewed by DEQ and EPA for protectiveness, and to determine if additional cleanup may be required*" (DEQ and EPA 2005). This post-ROD protectiveness review can be initiated within the upland source control program or as needed for future response actions of PHSS, including baseline sampling, long-term performance monitoring, five-year reviews, or where EPA or DEQ determines that there is insufficient data to assess whether the protectiveness goals of the Selected Remedy are being achieved such as during a remedial design sufficiency assessment.
- For river banks evaluated through the DEQ-led JSCS process, exceedances of CULs provided in ROD Table 17 and listed in guidance **Table 1** identify areas that must be evaluated for SCMs to meet the cleanup objectives of the ROD and to protect the Selected Remedy.
- The threshold values in **Table 1** (ROD Table 21) should be used in identification and remediation of hot spots in JSCS river banks within the DEQ upland source control program.
- Characterization and evaluation of JSCS river banks are to use a systematic planning process, including the sampling and analysis plan (SAP) and the quality assurance project plan (QAPP) to develop the data quality objectives (DQOs) and conceptual site model (CSM), as described in **Section 2.2** of this river bank guidance document.
- Implementing cleanup through the SCM (i.e., JSCS) process is to follow JSCS Section 4.6 and Figure 4-1 (DEQ and EPA 2005). After characterization, the process can integrate a risk-based decision step that includes exposures for current and future land uses to evaluate the appropriate action, including the application of ICs (JSCS Section 7.2).
- Procedures that supplement this guidance and state-led decisions are to be guided by and determined through the JSCS and can include active SCMs, ICs, or monitoring.

The scope of the DEQ uplands program is generally considered to have an administrative boundary that ends at the mean high water (MHW) elevation. However, for JSCS river banks, further characterization may be required based upon future response actions and implementation of the Selected Remedy at PHSS. The determining factors for further data collection include long-term performance monitoring and five-year reviews or when EPA or DEQ determines there is insufficient data to assess whether contamination sources to the Willamette River are controlled such that the protectiveness objectives for the Selected Remedy are met.

1.3 Remedial Action Objectives

The scope of this guidance integrates the RAOs of the Selected Remedy to develop a procedural framework that is consistent with the CERCLA requirements of the ROD. As presented in ROD Section 9, RAO 9 was developed to address river bank soil/sediment contamination to reduce risk to human health and ecological receptors and recontamination potential to the Selected Remedy (EPA 2017). CULs for river bank soil/sediment for RAO 9 are presented in Column 3 of ROD Table 17 (EPA 2017) and listed in **Table 1** of this guidance. The CULs are the long-term contaminant concentrations that need to be achieved to meet the RAOs and protectiveness goals of the Selected Remedy. RAO 9 is presented below:

- **RAO 9 – River banks: Reduce migration of contaminants of concern (COCs) in river banks to sediment and surface water such that levels are acceptable for human health and ecological exposures.** Reducing concentrations, exposure to, and the bioavailability of COCs in river banks will reduce risk and recontamination at the site. Ongoing source control efforts will provide additional risk and recontamination reduction.

The objective of RAO 9 is to be protective of human health and the environment with a cleanup value selected for each COC based upon the exposure scenarios and objectives of RAOs 1, 2, 5, and 6.

PHSS river banks are contiguous with riparian and aquatic habitat, and sources of contamination associated with these river banks must be controlled to achieve the goals of the Selected Remedy. The CULs were determined by selecting the lower concentration from the media-specific exposures of four RAOs or the background value if the protective value was lower than the background (see ROD Section 9.1). The CULs are listed in **Table 1** and include a column titled "Basis" that identifies the protection objectives for each CUL as related to human health risk, ecological effects, and background. The four supporting RAOs are as follows:

- **RAO 1 – Sediment: Reduce cancer and noncancer risks from incidental ingestion of and dermal contact with COCs in sediment and beaches to exposure levels that are acceptable for fishing, occupational, recreational, and ceremonial users** (**Figure 2**). Reducing concentrations, exposure to, and the bioavailability of COCs in nearshore sediment and beaches will reduce risk at the site. Ongoing source control efforts and the use of ICs (such as signs and fences) will provide additional risk reduction.

- **RAO 2 – Biota: Reduce cancer and noncancer risks to acceptable exposure levels (direct and indirect) for human consumption of COCs in fish and shellfish.** Reducing concentrations, exposure to, and the bioavailability of COCs in sediment will subsequently reduce surface water and fish and shellfish tissue concentrations and will reduce risk at the site. Ongoing source control efforts and the use of fish consumption advisories and education and outreach programs will provide additional risk reduction.

- **RAO 5 – Sediment: Reduce risk to benthic organisms from ingestion of and direct contact with COCs in sediment to acceptable exposure levels.** Reducing concentrations, exposure to, and the bioavailability of COCs in sediment will reduce risk at the site. Ongoing source control efforts will provide additional risk reduction.

- **RAO 6 – Biota (Predators): Reduce risks to ecological receptors that consume COCs in prey to acceptable exposure levels.** Reducing concentrations, exposure to, and the bioavailability of COCs in sediment will subsequently reduce surface water concentrations in fish and shellfish and will reduce risk at the site. Ongoing source control efforts will provide additional risk reduction.

RAOs address both current and future land and waterway uses. Specific to evaluating human exposures on river banks (inclusive of beaches, river banks, and sediment), PHSS ROD Section 8 identifies land use and prevailing exposures for tribal fishers and recreational beach users. See ROD Section 8.1.2.2 (EPA 2017). The beaches at PHSS indicated in **Figure 2** are identified as having a range of human users, including recreational beach users, transient users, and recreational, subsistence, and tribal fishers. The river bank characterization and implementation of cleanup must consider existing and future land uses. The recreational beach areas shown in **Figure 2** are adapted from the human health risk assessment in the Portland Harbor remedial investigation report (EPA 2016a).

Achieving PHSS RAOs relies on the Selected Remedy's ability to meet CULs. Cleanup levels were selected in the ROD from a combination of risk-based values, ARAR-based values, and background concentrations. Background values include naturally occurring concentrations and ambient concentrations (related to anthropogenic sources). Characterization and evaluation of river banks and the implementation of river bank SCMs or selection of a remedial technology must consider RAOs, remedial action levels (RALs), principal threat waste (PTW) thresholds, individual CULs, and river bank-specific factors. See **Section 4.0** of this guidance for implementing a cleanup process at a river bank.

1.4 Document Organization

This document is organized into the following sections:

- **Section 1.0 – Introduction and Scope**: Provides an overview of the PHSS ROD requirements for addressing river banks and the use of EPA and state authority for undertaking actions
- **Section 2.0 – Characterizing River Banks**: Describes the basis for characterizing chemical contamination and physical properties of river banks, sampling requirements, and methods for identifying the nature and extent of contamination present in the river bank and its physical properties and geomorphology
- **Section 3.0 – River Bank Erodibility Evaluation**: Outlines the minimum information needed and the decision process for assessing river bank erodibility
- **Section 4.0 – Cleanup Implementation Process**: Describes the decision-making process to implement the Selected Remedy for river banks and achieve the RAOs consistent with the CERCLA requirements of the ROD
- **Section 5.0 – References**: Lists the sources cited in the document

2.0 Characterizing River Banks

This section describes a systematic planning and quality control process for chemical and physical characterization of river banks that includes the minimum requirements and expectations for integrating PHSS ROD requirements to achieve RAOs in the evaluation process. The objective of this section is to identify the preferred sequence and describe the means for collecting comprehensive data of consistent quality at all river banks to support evaluating conditions and implementing cleanup consistent with PHSS ROD objectives. The following topics are included in this section:

- Identification of river bank and upland regions in PHSS (**Section 2.1**)
- Description of chemical characterization to identify the nature and extent of contamination in river banks (**Section 2.2**)
- Description of the steps for physical characterization of soil and sediment and the geomorphic configuration to support erodibility evaluations (**Section 2.3**).

The on-site work should be conducted in full awareness of all health and safety and data quality considerations for working within a Superfund site. Chemical and physical hazards associated with the conditions of the area being characterized are to be considered during the planning process. Characterization planning should use all available resources. Supporting documents, site-specific datasets, analytical results from pre-design sampling for SMAs, bathymetry maps, and other information can be found on the Portland Harbor interim data portal: http://ph-public-data.com/.

Characterization will require sampling of river bank soil and affected sediment for the full extent of contamination exceeding ROD CULs (**Table 1**). The DEQ upland source control program has conducted characterization of river banks at PHSS since 2005 and might have completed a source control evaluation (SCE) and/or an SCD that has pre-ROD characterization data. If completed and available, the pre-existing SCEs/SCDs and related river bank characterizations should be considered in the systematic planning process. In addition, the previous data are to be evaluated during the sufficiency assessment phase of in-river remedial design or as part of a source control review during other phases of implementing the Selected Remedy at PHSS (see **Section 4.0**).

As described in **Section 2.2**, the preferred process is based upon industry standard procedures for environmental or remedial design investigations and initially involves chemical characterization, beginning with a systematic planning process, including developing a detailed CSM and DQOs that are necessary to plan and conduct chemical characterization to identify the extent of contamination. This initial process integrates existing information such as site-specific chemical, physical, and anthropogenic characteristics of the site to address the study objectives. If analytical results of the samples indicate exceedances of river bank CULs, a second step is initiated to conduct a physical characterization of the river bank to evaluate contaminant transport to the river (see **Sections 2.3** and **3.0**).

2.1 River Bank Regions

PHSS ROD Section 14.2.5 defines a river bank as the area from the top of the river's bank and extending to the river that might be contaminated along the shoreline next to contaminated in-river shallow areas. **Figure 3** provides a schematic depiction of conceptual cross sections for different shoreline geometries along the Willamette River at PHSS. Key features include top of the bank and toe of the slope. The river bank diagrams shown in **Figure 3** are conceptual and for the purpose of depicting general regions to support planning. Based upon ROD Section 6.5 that describes contaminated media on a continuum for the river bank and shallow regions, **Figure 3** denotes the area between the top of bank and the −2 CRD as the river bank/shallow region subject to chemical characterization to meet site-specific study objectives. Chemical characterization is needed to meet the ROD objectives; identify the nature of contamination relative to CULs, RALs, and PTW thresholds; and inform remedial design when contamination is present.

2.1.1 Geomorphic Features and Elevations

The top of the river bank is determined on a site-specific basis and is generally defined as the point where the slope of the land surface changes from toward the river to toward the uplands. For the purposes of physical characterization and applying erodibility evaluations, such as the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model, the toe of the slope (shown in **Figure 3**) is a geomorphic feature defined as the first significant break in slope that is below ordinary high water elevation (OHW) and above MHW. It is necessary to define this reference point for standard application of the BANCS model within PHSS. Elevations on the conceptual river bank segments identify general spatial areas for planning and implementing data collection to meet river bank study objectives.

The reference elevations for tidal datums and other relevant water elevations are shown in **Figure 3** and are provided with values derived from different vertical datums. Elevations relative to the North American Vertical Datum of 1988 (NAVD 88) are considered the most applicable because NAVD 88 replaced the National Geodetic Vertical Datum of 1929 (NGVD 29) as the national standard geodetic reference for heights. The elevations for tidal datums are derived from measurements recorded at the Morrison Street Bridge (National Oceanic and Atmospheric Administration Station ID: 9439221, Portland Morrison Street Bridge, OR) in Portland, Oregon. The source URL for the tidal references is https://tidesandcurrents.noaa.gov/benchmarks.html?id=9439221. The OHW elevation is equivalent to 20.08 feet NAVD 88, as calculated in the U.S. Army Corps of Engineers (USACE) Portland Harbor hydrology document (USACE 2014).

2.1.2 Planning Access

River bank chemical and physical characterization should be planned and conducted when conditions are suitable for access to collect samples and other data from the top of the river bank down to mean low water (MLW). To achieve study objectives consistent with the ROD objectives, chemical data should be collected to at least the MLW, pending site access. The minimum extent for physical characterization is from the top of the bank to the toe of the slope, between OHW and MHW elevation, as required for the erodibility evaluation described in **Section 3.1**. Elevations shown in **Figure 3** are useful for planning and implementing data collection for river bank evaluations. The elevations do not identify the limits of characterization that might be necessary for evaluating contamination associated with cleanup at PHSS.

The uplands are defined as the portion of PHSS that includes the sources of contamination to the river, such as upland facilities. The upland areas are typically expansive, contiguous land areas with relatively flat or minimal topographic relief and are delimited riverward by a sharp break in topography and a slope downward to the river at the top of bank. Activity for uplands source control can be co-conducted with river bank data collection, pending access and study objectives.

2.2 Chemical Characterization of River Banks

The first step in river bank characterization is the development of a detailed CSM based upon a review of existing documents and data from previous site work. The CSM is used to guide the planning of river bank characterization and includes documented sources for the historic uses, construction, fill history, industrial operations, materials handled, and history of releases for the property and river bank. Chemical characterization, which includes sampling and analysis of river bank soil/sediment for contaminants that might be present, is necessary to determine the nature and extent of contamination in the river bank. After identifying the nature and extent of contamination relative to the CULs and SLVs, the erodibility of the contaminated areas of the river bank should be determined.

2.2.1 Spatial Considerations

For a shore-based effort, the chemical characterization of ROD river banks should extend from the top of the river bank to the MLW to determine if RAO protectiveness goals are met. The MLW is identified because it is the lowest extent where shore-based sampling can be practicably implemented and includes areas where humans and some ecological receptors are expected to be exposed to soil or sediment. Characterization can include in-river sediments beyond the MLW, as needed, to delimit the extent of contamination. For river banks with adjacent SMAs, this characterization can be performed by the upland parties, as needed for their purposes, or by the performing parties of the in-river SMA work. For river banks without an adjacent SMA or not identified in the ROD, the characterization is to proceed as a DEQ-led action, with characterization planning per this guidance (see **Section 1.2.3**). The extent and specific delineation of the SMAs might change after post-ROD data are evaluated. The planning and sampling activity conducted for characterization and/or remedial design should provide data consistent with the needs for designing and implementing cleanup per the ROD requirements or SCMs per JSCS. The extent and specific delineation of the SMAs might change after post-ROD data are evaluated.

2.2.2 Planning Steps

The ROD allows for flexibility when planning and performing the river bank work separate from the SMA if the work is compatible with the SMA remedial design. Characterization and remediation at ROD river banks and/or those adjacent to an SMA can be performed by upland performing parties and are expected to be consistent with the CERCLA process and meet the ROD requirements. Accordingly, the planning documents, which include the CSM, DQOs, and target analytes, will be prepared in a SAP/QAPP that requires EPA approval for work conducted under an administrative settlement agreement and order on consent (ASAOC) or similar enforcement tool or DEQ approval when conducted for a state-led activity.

The expected steps for delineating contamination within a river bank are as follows:

- Characterize the lateral extent of contaminant concentrations exceeding the criteria listed in **Table 1** (from ROD Tables 17 and 21) over the entire river bank. Spatial distribution and density of sample locations are to be designed in a SAP/QAPP to meet the investigation DQOs and collect data to support evaluations relative to RAO 9. When applicable, characterization data should be used to inform remedial design. Characterization should also provide data to confirm or deny the presence of nonaqueous phase liquid (NAPL) found in soil borings or wells at the top of the bank.
- If surface sample results exceed PTW threshold values, which are NAPL, highly toxic PTW, and not reliably contained (NRC) PTW thresholds listed in **Table 1**, subsurface sampling is necessary to vertically bound contamination exceeding PTW threshold values to the depth appropriate to support remedial action design.
- If results exceed CULs and/or RALs, vertical delineation of the extent of contamination would proceed to the depth appropriate to meet the investigation's DQOs developed in a preapproved SAP/QAPP. The depth of sampling must be sufficient to support evaluations relative to the protectiveness objectives of RAO 9 and, when needed, to support remedial design. Factors to be considered in delimiting the extent of contamination include those from DEQ's guidance, *Contamination Delineation for Cleanup Projects* (DEQ 2014), which includes a listing of state regulations for characterizing the "nature, extent, and concentrations of hazardous substances." Sampling techniques include but are not limited to hand augers, test pits, soil borings, monitoring wells, and trenches.
- Delineate NAPL through a combination of methods: visual identification, field screening methods, in situ methods (e.g., ultraviolet optical screening methods), laboratory analysis of soil samples, monitoring well installation with appropriately screened intervals, and monitoring for the presence of NAPL using an oil-water interface probe.

2.2.3 Analyte Selection

Chemical characterization of the river bank should consider the PHSS COCs and RAOs presented in the ROD. The preferred, or default, comprehensive and conservative list of analytes are those COCs with CULs listed in **Table 1**, referred to as river bank COCs per ROD Table 17. The SAP/QAPP develops specific DQOs based on the CSM elements related to past property uses, industrial processes, sources, known or suspected releases, and pathways, including transport and direct exposure to ecological receptors and humans. Depending upon the nature of the study, the DQOs can include the rationale for collecting initial remedial design data for remedial technology assignments. **Table 1** provides the list of PHSS COCs for river bank soil/sediment and the CULs based upon protection of the Selected Remedy and RAO goal achievement. For stat-led activity, additional analytes can be included to support the evaluation of JSCS SLVs. The list of contaminants to be analyzed for river bank chemical characterization requires approval by EPA for work conducted per an ASAOC or similar enforcement tool or by DEQ for state-led river banks. Development of the suite of analytes for the study and applicable comparison criteria, should consider the CSM, the nature of COCs in the adjacent or nearby SMA, the history of site activity, past releases, and site-specific considerations for achieving the study and the cleanup objectives. The selection of site-specific analytes must consider that the ROD has selected the CULs to be protective of all receptors (see **Section 1.3**); therefore, river bank COCs are not expected to be excluded based solely upon localized or site-specific receptor exposure scenarios.

For JSCS river banks within the DEQ upland program, inclusion of chemicals other than the PHSS COCs is a site-specific decision in the JSCS process and might be applied for characterizing JSCS river banks using the relevant chemicals and their JSCS SLVs.

2.2.4 Quality Assurance Plans and Sampling Design

The scope of chemical characterization should follow the systematic planning process and be based on the CSM, study objectives, and nature of COCs in the nearshore sediment and/or the adjacent SMA. The study objectives and DQOs should include the presence of habitat, potential direct contact exposure to human and ecological receptors, and pathways for leaching and transport of contaminants to the river. The initial assessment and planning for chemical characterization are to include the type and extent of existing contaminant concentrations, including those chemicals in nearshore sediments or the adjacent SMA.

All sampling and analysis to delineate areas of contamination in the river bank must be performed based upon a preapproved SAP/QAPP (see **Section 2.2.2**). The SAP/QAPP must provide a river bank CSM that describes the historical industrial site use, identifies potential or known releases, and describes other site-specific activity that could affect river bank soil/sediment. The CSM for PHSS river banks is described in ROD Section 6 and is based upon the industrial development history of river bank construction by emplacement of fill material, most often comprising dredged river sediments and fill from other unknown sources.

The SAP/QAPP must be developed following the DQO process (EPA 1993, 2000). The DQO statements and decision rules are to be determined by and based upon the river bank CSM and are to address the risk-based RAOs for river bank soil/sediment (see **Section 1.3**). The planning objectives support the characterization goal of defining the extent of contamination relative to the CULs, RALs, and PTW threshold values in **Table 1** and to JSCS SLVs. Following the DQO process, the SAP/QAPP will determine sample locations, depths, sampling density, sampling methods, and analytical methods that are suitable for representative sampling and delineation of the lateral and vertical extent of contamination in the river bank.

Guidance is provided in EPA QA/G-5S (EPA 2002) for the development of the sampling design and decision rules in the SAP/QAPP. The following general sampling approaches should be considered when conducting river bank sampling for chemical characterization:

1. Probabilistic-based sampling design using discrete samples to define remediation limits based on criterion in **Table 1** per ROD Tables 17 and 21
2. Incremental sampling methodology (ISM), multipoint composite sampling, or discrete sampling to determine a robust estimate of mean concentration (e.g., 95% upper confidence level of the mean value)
3. Judgmental sampling using discrete samples to identify potential locations based upon site conditions and areas of potential contamination (e.g., areas of documented stained soil or NAPL in the river bank or areas around an outfall).

River bank soil/sediment characterization by Sampling Approach 1 and supplemented by Sampling Approach 3 are to be used to determine the locations where CUL, RAL, or PTW thresholds are exceeded on a point-by-point basis. A sampling design based upon Sampling Approach 2 is appropriate for estimating average concentrations of predetermined decision units for supporting an assessment of discrete confirmation sample results, or supporting risk-based decisions, or making mass flux or other estimates over a river bank reach. Sampling Approach 2 is not considered the most appropriate method for initial chemical characterization of a river bank for which the primary goal of sampling is to identify and delineate areas where contaminant concentrations exceed CULs, RALs, and PTW thresholds. Sampling Approach 2 is considered an appropriate method for post-river bank removal confirmation sampling if the river bank has been excavated to a design depth consistent with the requirements of the ROD (see Sections 14.2.4, 14.2.5, and 12.2.9) and as shown in **Figure 4**. If ISM in Sampling Approach 2 is used, the SAP/QAPP development is to follow the Interstate Technology & Regulatory Council's (ITRC) guidance document, *Incremental Sampling Methodology. Technical and Regulatory Guidance* (ITRC, 2012). Coordination with the analytical laboratory, if performing ISM analyses, is an important part of the development of the SAP/QAPP and the DQOs.

2.2.5 Analytical Reporting Limits

The analytical methods planned in the SAP/QAPP are expected to achieve reporting limits that are less than the pertinent criteria used in the evaluations (i.e., PHSS CULs and JSCS SLVs). The QAPP is expected to specify use of the best available sampling and analytical techniques to achieve the required reporting limits. If the sampling techniques and analytical methods cannot achieve reporting limits compatible with the criteria, the QAPP must describe whether such data can be used to meet the study objectives and what effects the reporting limits have on achieving the objectives. Specific details and expectations are described in JSCS Section 3.3.

2.3 Physical Characterization of River Banks

Implementing the PHSS Selected Remedy per the ROD and conforming with JSCS requirements (JSCS Section 5.1.2) involves evaluating the erodibility of river banks to identify those that require stabilization of erodible soils as a component of the cleanup implementation. Erodible soils with contaminant concentrations exceeding the criteria in **Table 1** require action to meet PHSS objectives, specifically as described in RAO 9 (see **Section 1.3**). The following subsections describe the physical characterization parameters needed to support the erodibility evaluations described in **Section 3**.

2.3.1 River Bank Physical and Material Characteristics

Physical and material characteristics of a river bank, coupled with erosive forces, determine its stability and the potential for soil to erode into the river. An initial assessment is performed to identify representative sections of the river bank and their characteristics. This initial assessment is completed as part of an initial site reconnaissance for scoping chemical and physical characterization of the river bank. Geomorphic areas or segments of the river bank with different physical and material characteristics are to be evaluated individually because of the unique potential for erodibility. Representative sections can be identified by the following physical and material characteristics: height of the bank, slope angle, soil type, and amount and type of surface protection (e.g., bank armoring, amount of vegetation, and the presence of erosional features such as erosional scours, scarps, or slumps). This initial assessment involves a review of existing site information and site reconnaissance. When reconnaissance during the initial assessment identifies new erosion scarps or other features that are not present on existing maps or surveys, the application of real-time information obtained during the initial assessment takes precedent over older existing site information.

Evaluation of existing site information is to include a review of available site plans, topographic maps, aerial photographs, lidar maps, geologic maps, available soil survey information in the vicinity, sampling data, boring logs, and geotechnical reports. On-site topographic surveys are typically completed along specific transects perpendicular to the river to support creating profile sections for conducting evaluations. In addition, bathymetry maps, in GIS format, are available for the Willamette River and include nearshore areas adjacent to river banks. Time series bathymetric data can be used to assess erodibility of the lower elevation portion of the river bank that is lower in elevation than the area covered by the BANCs model evaluation (i.e., riverward of the topographic toe of slope or MHW). River bathymetry data collected in March and June 2018 are available on the Portland Harbor interim data portal.

The review should be verified through site reconnaissance, which includes visual observations, topographic measurements, field testing needed to verify river bank soil types, and photographs to document the physical characteristics of the river bank. The following paragraphs describe the physical and material characteristics used to evaluate river bank erodibility and bank stability. **Section 3** includes a discussion of methods for evaluating these physical and material characteristics to determine the erodibility of the river bank.

Height of Bank and Bankfull Level

River bank height affects river bank stability and the potential for slope failure. River bank height, as measured from the top of the bank to the toe of the slope, should be determined from topographic and bathymetric maps or measured in the field using survey methods. The industrial setting and history of physical alterations produce the engineered nature of many river banks at PHSS (see ROD Section 6.2). Consequently, the top of the bank and the toe of the slope are not obvious at many locations. As described in **Section 2.1**, the top of the river bank is defined as the point where the slope of the land surface changes from toward the river to toward the uplands. The toe of the slope is defined as the first significant break in slope that is below OHW but above MHW. As shown in **Figure 3**, if the toe of bank above MHW cannot be determined at a river bank transect location, then the MHW elevation should be used as a proxy for the toe of bank elevation. At PHSS, based upon Willamette River gauging data, OHW elevation is equivalent to 20.08 feet NAVD 88, as presented in the USACE Portland Harbor hydrology document (USACE 2014). Converted values from NGVD 29 and CRD to the currently used NAVD 88 are provided in **Figure 3**. The source URL for the tidal references is https://tidesandcurrents.noaa.gov/benchmarks.html?id=9439221.

Bankfull level is the point on the river bank that contains normal non-flood-level flows of the river throughout the year and is typically identifiable by visible changes in topography, vegetation type, or sediment grain size. For the Willamette River, the bankfull level is approximated by the OHW elevation, which is equivalent to 20.08 feet NAVD 88, as presented in the USACE Portland Harbor hydrology document (USACE 2014).

Bank Angle

The river bank slope (bank angle) affects river bank stability caused by erosive forces of the river, overland runoff, and slope failure. For the purpose of the BANCs model evaluation, the relevant portion of the bank for determining bank angle is from the toe of the slope to the top of the bank. The maximum bank angle between the toe of the slope and top of the bank should be used in the erodibility assessment because it is the condition most prone to erosion or failure. The bank angle can be determined from topographic or bathymetric maps or measured in the field using a clinometer or other suitable direct field measurement technique.

River Bank Soil Types

Soil types affect river bank stability owing to potential for erosion from erosional forces of the river, overland runoff, and slope stability failure. In general, granular sandy soils with minimum fine content and low cohesion are more susceptible to erosion and bank failure. River bank soil types should be determined in the field through visual inspection and by field classification methods. A standardized soil classification system, such as the Unified Soil Classification System determined by ASTM International Standard D2487-17, is to be used to describe the soil types. The procedures described in ASTM Standard D2488-00, *Standard Practice for Description and Identification of Soils* (ASTM D2488), can be used to perform field classifications. Field sieve analysis can be used to supplement visual classification and verify grain-size distribution.

River Bank Surface Protection

Surface protection is the amount of the river bank that is covered and protected by woody debris, rooted vegetation, embedded boulders, revetment, bedrock, or other embedded materials that protect the bank from erosion. Information on existing armoring and vegetation on a river bank should be obtained during the initial assessment and site reconnaissance to determine the surface protection of the river bank. **Section 3.1** describes of the process and information for evaluating river bank erodibility.

River bank armoring protects river bank soils from erosional forces of the river, wave action, and overland runoff. Armoring can include riprap, rock, gravel, concrete, gabions, retaining walls, and other natural or man-made materials. During the site reconnaissance, river bank armoring should be assessed, including the type and size of armoring; location of armoring relative to the toe of the slope, top of the bank, and OHW elevation; percent of the river bank surface covered by armoring; and general condition of armoring (i.e., determine whether the material is stable, unstable, or sloughing into the river).

Vegetation on river banks can stabilize and reduce the potential for erosion. Root penetration into the soil acts as a natural anchoring system and can limit erosion as a result of mass wasting or slope failure. Vegetation also offers surface protection of river bank soils by reducing erosion caused by erosional forces of the river, wave action, and stormwater runoff. During the site reconnaissance, river bank vegetation should be assessed, including vegetation type, rooting depth, root density, and the percent of the river bank surface that is covered by vegetation. Rooting depth is the maximum depth of plant roots in the river bank, and root density is the percent of subsurface soil within the vegetation root penetration depth that is composed of roots.

Visible Indicators of Active River Bank Erosion

Active erosion caused by stormwater runoff, mass wasting, erosional action of the river, or other geotechnical factors typically results in geomorphic features, such as erosional scours, scarps, slumps, landslides, or other forms of slope failure. These features can sometimes be identified through visual inspection or from aerial photographs and/or topographic maps. During the site reconnaissance, erosional scours, scarps, slumps, and landslides on the river banks should be mapped and evaluated in the erodibility assessment as a location of current and future erosion of soil to the river.

2.3.2 River Characteristics Related to Erosion

Moving water in the river can result in erosion of the river bank through entrainment of soil particles (Rosgen 2001, 2009). Moving water and erosional forces at Portland Harbor can result from river flow, wind- and boat-induced waves, and tidal changes (EPA 2016a). The erosional forces of the river acting on a given section of river bank is dependent upon several factors, including the alignment of the river relative to the river bank and site vicinity, river width and depth, stream velocities and stage elevations, and wind- and boat-induced waves. As part of the river bank erodibility assessment, each of these factors should be determined on a site-specific basis.

Alignment of the River

The alignment of the river relative to the river bank affects the erosional forces on river banks. The lowest erosional force typically occurs along straight sections of the river or on the inside of a bend, and the highest erosional force typically occurs on the outside of the bend. Erosional forces on river banks increase with increasing tightness of the radius of a bend. As part of the river bank erodibility assessment, the location of the river bank relative to bends in the river should be determined, and the radius of the bends should be measured. This information can be obtained from site maps or online map resources.

Width and Depth of the River

Changes in river channel width and depth can change river velocity and result in higher erosional forces on the river bank. Locations of deep pools on the outside of a bend in the river can indicate locations of higher erosional areas and identify areas of active erosion. Site-specific river width and depth information can be obtained from site maps, topographic maps, bathymetric maps, or online map resources.

Stream Velocity and Stage

Stream velocity and stage at the river bank determine the erosional force acting on the river bank. Stream velocity and stage are driven by precipitation, snowmelt, tidal changes, groundwater recharge, and the geometry of the river. In general, the higher the stream velocity, the higher the potential for soil particles to be entrained in the water. As part of the river bank erodibility assessment, stream velocities at the OHW level and 100-year flood events (based on Morrison Bridge gauge [http://orsolutions.org/wp-content/uploads/2014/10/Historic-High-Water-Portland-Fact-Sheet.pdf]) should be determined for the river bank being evaluated (USACE 2014). Sources of current, historical, or predicted stream velocity and stage data at Portland Harbor include but are not limited to the U.S. Geological Survey gauging station located at the Morrison Bridge, USACE Hydrologic Engineering Center River Analysis System model of the lower Willamette River, stream discharge measurements collected from the Willamette River during the PHSS remedial investigation (EPA 2016a), and site-specific stream velocity surveys. Bed-shear modeling or the PHSS remedial investigation are useful sources of information for characterizing dynamic forces from the river in proximity to the river bank.

Wind- and Boat-Induced Waves

Wind and boat traffic can produce waves capable of eroding soil from river banks. Visual inspection of wave-induced erosion of the river bank is to be completed during site reconnaissance and used to supplement the assessment of erodibility described in **Section 3**.

3.0 River Bank Erodibility Evaluation

The Portland Harbor JSCS (DEQ and EPA 2005) developed guidelines for evaluating the erosion potential of river bank soil into the Willamette River. JSCS Section 5.1.2 states that the weight-of-evidence evaluation includes the following elements:

- River bank stability (e.g., potential erosion from extreme rainfall events, potential for erosion caused by flood conditions, bank erosion rates)
- Soil properties (e.g., soil type, compaction, erodibility, permeability)
- Evaluation of potential soil erosion and contaminant transport (e.g., modeling, quantitative erosion calculations).

Implementing the PHSS Selected Remedy per the ROD and conforming with JSCS requirements involves evaluating the erodibility of river bank areas to identify contaminated river banks requiring SCMs or other actions if the erodible soils are found to exceed ROD Table 17 CULs (see **Table 1**). A standardized approach for evaluating river bank erodibility is needed to ensure consistency of evaluations across PHSS. The following sections describe the standardized approach, parameters, and methods to physically characterize and evaluate river bank erodibility at both ROD river banks and JSCS river banks.

3.1 Methods for Erodibility Evaluation

Data and information collected during the initial assessment and site reconnaissance should be evaluated either through qualitative assessment or quantitative river bank erosion rate modeling. The BANCS model is presented as one example of a quantitative evaluation method. Considerations for conducting a qualitative assessment or quantitative BANCS model estimate of erodibility potential are discussed in the following subsections.

3.1.1 Qualitative Erodibility Evaluation

A qualitative evaluation can be performed to determine the potential for erosion at each representative section of the river bank, considering physical characteristics of the river bank discussed in **Section 2.3.1** and the expected river-dependent erosional forces discussed in **Section 2.3.2**. For areas having surface protection in place, such as armoring and vegetative cover, the current condition and current/future protectiveness of the surface protection should be evaluated. For areas lacking surface protection, an assessment of the potential for the river bank soil to erode to the river should be made using professional judgment, considering the river bank height, slope angle, soil type, expected frequency, and magnitude of surface runoff; expected river stage and flow velocities; and expected wave frequency and height. Qualitative evaluation can also consider historical information regarding how long the bank has been in place and if the bank has been previously affected by historical flood events. Areas of the river bank determined to be erodible through the qualitative assessment can be further assessed through a more quantitative assessment. A quantitative assessment of erodibility is required for river banks where chemical characterization data show soil concentrations of COCs exceed the PHSS CULs listed in **Table 1** and in Table 17 of the ROD**.**

3.1.2 Quantitative BANCS Model Evaluation

The BANCS model predicts river bank erosion using the erodibility potential of the bank determined by two factors: bank erosion hazard index (BEHI) and erosional forces represented by near-bank stress (NBS) of the river acting on the river bank. The BANCS model was developed based on empirical relationships between BEHI, NBS, and erosion rates documented at active streams and rivers in case studies. The BANCS model uses empirical information; therefore, parameters are not adjustable or scalable to accommodate different rivers. The case studies did not include large rivers in industrial settings, such as Portland Harbor, which has other river bank erosion mechanics not covered by the BANCS model (e.g., wind- and boat-induced waves, tidal action, and overland runoff erosion of the bank). However, the BANCS model is useful for evaluating river bank erosion related to BEHI and NBS. The BANCS model was first developed by Rosgen 2001, and a more detailed presentation of the method is presented in Rosgen 2009. Detailed descriptions of field observations to determine BEHI, NBS, and use of the BANCS model to predict river bank erosion rates are included in Rosgen 2009 and Starr 2013. Case studies that evaluate the BANCS model and use the model to predict river bank erosion rates are provided in Rosgen 2009 and Bigham 2011. Other methods of performing quantitative erodibility evaluations can be used but should be equivalent to the BANCS model and are subject to EPA and/or DEQ approval before use.

The parameters used to determine BEHI are:

- Height of the bank
- Bankfull level
- Rooting depth
- Root density
- Bank angle
- Surface protection
- Bank composition
- Bank material stratification

Rosgen (2009) provides details for assessing the eight BEHI variables. Each BEHI variable is given a rating (score) from very low (0 to 2 points) to extreme (9 to 10 points). The scores are summed to calculate an overall BEHI rating for the stream bank reach of interest. The overall BEHI rating ranges from very low (5 to 9.5 points) to extreme (46 to 50 points) per Rosgen (2009).

NBS is determined in the BANCS model by one or more of seven methods presented by Rosgen (2009). These methods involve considering stream geometry, presence of depositional and erosional geomorphic features, and actual stream velocity to determine the NBS parameter. The most appropriate method for NBS determination should be based on site-specific characteristics and professional judgement. NBS provides a rating using one of seven methods to generate a numerical score that determines a ranking from very low to extreme.

The BEHI and NBS values calculated using site-specific physical and material characteristics (empirical data) of the river bank and the characteristics of the river are plotted on existing bank erosion curves presented in the BANCS model documentation to determine river bank erosion rates (Rosgen 2009; Starr 2013). However, these erosion rate curves are only statistically valid for the streams from which they were derived and not universally applicable to other streams or rivers for estimating river bank erosion rates.

3.2 Determination of Erodibility for All River Banks

The following information and evaluations are necessary at early stages of a ROD river bank remedial design or a DEQ upland source control program river bank SCE to determine river bank erodibility after chemical characterization is conducted:

- Quantitative erodibility evaluation: The erodibility of a river bank should be evaluated using the BANCS model or equivalent method, as described in **Section 3.1**. The evaluation should include application of the BEHI and NBS throughout representative sections of the river bank. The individual BEHI variable scores are summed to obtain a total score. The total scores are applied to assign an overall BEHI rating range. Areas having an overall BEHI rating and/or NBS of moderate to extreme (indicating significant erosion potential) should be weighted more heavily in the weight-of-evidence approach for evaluating the river bank erosion pathway.

- Supplemental evaluation: A limited evaluation of erosion based on the observations made during the site reconnaissance (see **Section 2.3**), including erosional features related to overland runoff, flooding above bankfull level, wind- and boat-induced waves, and tidal fluctuations, are to be included as a supplement to the BANCS model results because these processes are not included in the BANCS model. The requirements for a supplemental evaluation are described in **Section 3.3.** The supplemental evaluation is needed specifically for river banks of low to medium priority, as identified in the DEQ upland program and by those river banks with a BANCS model assessment result indicating low erosion potential. For river banks at which the BANCS model assessment indicates medium to extreme erosion potential, the supplemental evaluation is to be addressed during source control or remedial design.

The potential for significant erosion can be determined through quantitative scoring results from the BANCS model with moderate to extreme BEHI and/or NBS and/or the supplemental evaluation observations of erosion. While a performing party can provide their preliminary determination based on the information and analysis listed above, EPA (ROD river banks) and DEQ (JSCS river banks) will review the evaluations to make a final determination of river bank erodibility.

3.3 Supplemental Evaluation for Low- and Medium-Priority River Banks

Low- and medium-priority (as determined in DEQ's upland program) river banks that have COCs at concentrations greater than PHSS CULs but less than the sitewide RALs and are determined to have low erodibility based on the BANCS model (or an equivalent quantitative method) require a supplemental erodibility evaluation to support a cleanup implementation decision that meets the protectiveness objectives of the Selected Remedy (see **Section 4.1**). The supplemental evaluation should apply information from the visual inspection of the river bank for erosional features that are not accounted for in the BANCS model. These other erosional factors include overland runoff, flooding above bankfull level, wind- and boat-induced waves, and tidal fluctuation (see **Section 2.3.2**).

3.4 Remedial Design Erodibility Evaluations

If the results of the erodibility assessment indicate the potential for significant erosion, a more detailed remedial design evaluation might be required. Potential for significant erosion is a BANCS model (or an equivalent quantitative method) BEHI and/or NBS scoring of moderate to extreme, and/or supplemental evaluation observations of erosion. The remedial design evaluation would go beyond the visual inspections in the supplemental evaluation described in **Section 3.2** and is to include the following additional factors:

- River bank erosion caused by overland runoff
- Erosion resulting from anthropogenic causes such as foot paths or vehicles
- Erosional forces during flood conditions above bankfull level
- Erosional forces caused by wind waves
- Erosional forces caused by boat wakes
- Assessment of the condition of the river bank surface, including historical slope failures
- Examination of the bank for areas of groundwater seeps and piping that might affect the bank stability
- A detailed topographic survey by an Oregon-licensed land surveyor to establish the slope height and slope inclination of the entire river bank
- A limited field investigation, including borings and laboratory testing of soil, to characterize the subsurface conditions of the river bank
- Slope stability analysis performed under the supervision of an Oregon Professional Engineer with expertise in geotechnical engineering or a Certified Engineering Geologist

The assessment of erosion caused by waves is to include a review of local weather monitoring data to determine expected wind conditions at the site and the frequency and maximum wave heights based on the data and a review of information related to the frequency and type of boat traffic expected near the river bank. Wave analysis in the PHSS feasibility study (EPA 2016b) and in *McCormick and Baxter Sediment Cap Basis of Design* (Ecology and Environment 2002) are existing sources of information for wind- and boat-induced waves at Portland Harbor sites.

4.0 Cleanup Implementation Process

The cleanup implementation process is described in this guidance based on the nature and extent of the contamination and the physical conditions of the river bank that were determined through the characterization steps described in **Sections 2.0** and **3.0**. The management of cleanup, as discussed in **Section 1.0,** follows the ROD, JSCS, and MOU, provides for distinct administrative roles for implementing cleanup for river banks at PHSS. The roles described in this guidance are relative to ROD river banks (inclusive of those pending characterization) and JSCS river banks. ROD river banks will be addressed through CERCLA authority in conjunction with the PHSS in-river action if there is an adjacent SMA. River banks categorized as JSCS river banks will continue to be addressed with state authority (OAR 340-122-0010 to 0140) through the DEQ upland source control program and might require further characterization if determined by the upland program and/or the future response action phases during design and implementation of the Selected Remedy for PHSS. **Section 1.2.3** provides an overview of JSCS river bank characterization within the post-ROD scenario and follows the DEQ upland source control program.

Habitat Considerations

An important part of implementing the Selected Remedy is balancing remediation to achieve RAO goals while promoting and protecting habitat. This balance between remediation and habitat improvement is addressed through the remedial design and interagency coordination/consultation process (see ROD Sections 10.1, 14.2.9, and 15.2.2). This river bank guidance does not provide specific approaches to incorporate habitat improvements into river bank source control and cleanup actions other than references to ROD sections that describe the habitat obligations and regulatory requirements. For river banks entering the remedial design or SCM/SCD phase, the planning process should involve early coordination with the natural resource service agencies, National Marine Fisheries Service, and U.S. Fish and Wildlife Service to ensure incorporation of riparian and in-river habitat improvements into the river bank remedial design process. The coordination process is described in PHSS ROD Section 15.2.2 as part of the requirements for compliance with location-specific ARARs during implementation of cleanups. Failure to consult with the agencies early in the remedial design process could result in design changes that could delay a remediation project.

Existing River Bank Source Control Decisions

The DEQ upland source control program has implemented cleanup of river banks at PHSS since 2005. Some sites might have completed a DEQ-issued SCD before the PHSS ROD was issued. Some of these SCDs might have excluded the river bank erosion pathway or determined that no further action was needed at river banks found to have low risk of contamination to the river. Alternatively, SCDs might have required the implementation of SCMs for river banks found to have higher potential for contaminant migration to the river. Pre-existing river bank cleanup decisions are reviewed and evaluated during the sufficiency assessment phase of an in-river remedial design or as part of a source control review during other phases of implementing the Selected Remedy at PHSS. Based on the results of the sufficiency assessment or source control review, further cleanup and/or revision of SCMs might be necessary. This process is identified in JSCS Section 1.1, which states that "once the in-water Portland Harbor ROD(s) and cleanup goals are established by EPA, upland source control decisions need to be reviewed by DEQ and EPA for protectiveness and to determine if additional cleanup may be required."

The following sections provide a description of the cleanup implementation process for the ROD river banks and river banks adjacent to an SMA pending characterization.

4.1 ROD River Banks

ROD river banks in **Figure 1** and **Table 2** are defined in this guidance as river banks identified in Section 6.6.6 and Figures 9 and 30 of the ROD. Information for the ROD river banks and associated upland properties are in the ECSI database and described in the DEQ 2016 Portland Harbor Upland Source Control Summary Report (DEQ 2016). The locations, names, and upland ECSI numbers for the ROD river banks are listed in **Table 2** and mapped in **Figure 1**.

4.1.1 Sufficiency of Past Decisions

Some ROD river banks might have a DEQ-authored SCD that predates the PHSS ROD and are assumed to meet the protectiveness goals of the Selected Remedy. During remedial design, these past SCDs are to be reviewed by EPA and other parties as part of the sufficiency assessment. The sufficiency assessment is part of the remedial design of SMAs conducted under an ASAOC or similar enforcement tool and includes a review of the river bank pathway. The sufficiency assessment, as related to the river bank pathway, will be used to determine if existing river bank SCDs are sufficient or if additional river bank characterization and/or control are required. The river banks can also be reviewed as needed for future PHSS response actions, including baseline sampling, long-term performance monitoring, and five-year reviews, or where EPA determines there is insufficient contaminant data to assess whether the protectiveness goals for the Selected Remedy are being achieved. PHSS ROD Section 14.2.7 describes the requirements of the long-term monitoring program. Long-term monitoring of river banks will include performance monitoring of river bank source control and remedial action components, or it might occur as river bank sampling to determine sources of contamination at a specific reach of the river that is not achieving MNR objectives.

Appendix B provides the EPA requirements for the scope of a remedial design-related sufficiency assessment (as of June 14, 2019). If the ROD river bank, or portions thereof, does not have an adjacent SMA (see **Figure 1**), an evaluation is necessary to determine if the existing river bank characterization data and/or upland actions are sufficient to control potential recontamination from upland (direct discharges, groundwater, river bank, overwater) sources such that they will not adversely impact the short- or long-term effectiveness of the Selected Remedy. Results of the sufficiency assessment are to be incorporated into the remedial design or an SCD process specific to the river bank property. If a sufficiency assessment determines that river bank sources either are not controlled or data are insufficient to make this determination or to support remedial design, previous decisions for the upland sources are to be reviewed and additional characterization performed.

4.1.2 Decision Process

The cleanup implementation process is described in this guidance based on the following general scenarios (as listed in **Table 1**) determined by the nature of the contamination and physical conditions of the river bank:

1. River bank soil/sediment with COC concentrations greater than the PTW threshold values.
2. River bank soil/sediment with COC concentrations greater than the RALs but less than the PTW threshold values for erodible and non-erodible conditions
3. River bank soil/sediment with river bank COCs at concentrations greater than the CULs but less than the RALs for erodible and non-erodible conditions

For PHSS river banks requiring additional data collection, a SAP/QAPP is necessary to address data gaps. The SAP/QAPP must be submitted for review and approval to EPA for work conducted under an ASAOC or similar enforcement tool and to DEQ if the work is state led. The scope and minimum requirements of a SAP/QAPP for river bank characterization are described in **Section 2.2**.

The cleanup implementation process for characterizing and addressing contamination in ROD river banks is outlined in **Figure 4**. A summary of this decision process follows.

Active remediation (see ROD Section 14.2.5) areas for ROD river banks are defined by the extent of:

- NAPL, as identified in wells at the top of the bank or other locations within the river bank
- PTW thresholds listed in PHSS ROD Table 21 (see **Table 1** of this guidance)
- Soil/sediment-containing concentrations exceeding the sitewide RALs listed in PHSS ROD Table 21 (see **Table 1** of this guidance)

The presence of river bank soil with contaminant concentrations greater than the PTW threshold values (ROD Table 21) is of concern because of the difficulty involved in preventing migration of these highly concentrated and/or mobile contaminants to the river. Within PHSS, the most significant source material, described in the ROD as PTW, is categorized as three types (see footnotes in **Table 1**): (1) highly toxic contaminants that exceed the 10^{-3} risk value (identified by the PTW threshold values); (2) NAPL; and (3) contaminant chemicals, specifically chlorobenzene with concentrations greater than 320 micrograms per kilogram (µg/kg) or naphthalene concentrations greater than 140,000 µg/kg, which are considered not reliably contained by a remediation cap (see **Table 1**).

For PHSS river banks with soil/sediment that contain contaminant concentrations greater than the PTW threshold values of ROD Table 21 (see **Table 1**), a full characterization and horizontal and vertical delineation of the contamination over the entire river bank is to be performed. This includes the presence of NAPL found in soil borings or monitoring wells at the top of the river bank. The decision to implement components of the Selected Remedy must be approved by EPA for work conducted under an ASAOC or similar enforcement tool and by DEQ if conducted under state lead as is prescribed by and consistent with ROD Sections 14.2.5 and/or Sections 14.2.9.1 and 14.2.9.5. These ROD sections identify slope, erosion, and habitat considerations and other design factors for excavation and/or cap or a significantly augmented cap if complete removal of contamination is not feasible (EPA 2017). The specific component of the Selected Remedy and remedial action technology is determined on a site and location basis and, where applicable, is consistent with the adjacent in-river remedial action. The PHSS ROD indicates a preference to design remedial actions on the river bank with appropriate slopes by establishing native vegetation and using bioengineering techniques, where possible, rather than hardened banks to mitigate erosion. As described in ROD Section 14.2.10, the remedial design is to have performance standards and, if necessary, compensatory mitigation projects for riparian habitat. Selection of the remedial technology and design factors follows a CERCLA process to evaluate the technologies within the Selected Remedy to determine the component that will achieve the objectives on a specific river bank. The goal is to implement the Selected Remedy as appropriate for the specific river bank and to meet the requirements of the ROD.

For ROD river banks with soil/sediment that contain contaminant concentrations greater than the RALs but less than the PTW threshold values, an erodibility evaluation is necessary to determine the areas of the river bank that are erodible. If a river bank contains erodible soil with contaminant concentrations greater than RALs, it should be excavated to a minimum depth of 5 feet and backfilled with a cap constructed per ROD Section 14.2.9.1 requirements or evaluated for an alternative action to meet the protectiveness objectives of RAO 9. The minimum excavation depth is identified as guidance for a depth of excavation to support cap design that meets the habitat obligations and minimizes floodway restrictions. Non-erodible river bank soil with contaminant concentrations greater than RALs but less than PTW threshold values are to be evaluated through a CERCLA process to select a remedial technology from the Selected Remedy, whether it be an active or passive action, and to be consistent with the PHSS ROD. The process would involve a review of technologies used for components of the Selected Remedy to evaluate actions specific to a river bank area, including excavation, capping, monitoring, ICs, or a combination of components of the Selected Remedy, to achieve the objectives of the Selected Remedy.

For ROD river banks with contaminant concentrations in soil/sediment greater than CULs but less than sitewide RALs, the need for an action would also proceed through a risk-based decision process. This would include a CERCLA process to complete an evaluation of the technologies within the Selected Remedy to determine the component of the Selected Remedy that will achieve the objectives on a particular river bank. This process, conducted during pre-remedial design activity, would identify and select an action commensurate with the risk and consistent with the RAOs for river banks related to erodibility of the river bank, human exposure, ecological risk, and recontamination of the in-river remedy. The conclusions from the erodibility assessment would be used to determine what areas of the river bank exceeding CULs are erodible and require an action to meet the objectives of the Selected Remedy and prevent recontamination of the in-river remedy. A similar process is prescribed in JSCS Section 4.6 and, for erodible river banks, in JSCS Section 5.1.2 (DEQ and EPA 2005). Non-erodible areas of the river bank with soil concentrations exceeding the CULs (but less than RAL values) must achieve the protectiveness goals of the Selected Remedy (RAO 9) and be monitored to ensure the areas do not become erodible in the future. After an evaluation, a non-erodible river bank can be left undisturbed if a long-term monitoring program is implemented.

4.1.3 Confirmation and Monitoring

After an active remedy or SCM, such as excavation or regrading of a remediation area, confirmation samples must be collected from the leave surface of completed excavations and analyzed for the contaminants listed for river bank soil/sediment in ROD Table 17 (**Table 1**). Confirmation sampling is necessary before backfilling, erosion protection, and/or habitat work to confirm removal of soil exceeding the cleanup criteria. In areas where contaminant concentrations of confirmation samples are greater than CULs and soil is erodible, further action might be required to prevent the erosion of contaminated soils into the river and recontamination of the in-river remedy.

When the action involves the design and construction of an erosion-resistant cover, the cover is to include soft stabilization techniques such as slope-angle reduction and plantings where feasible. A high visibility demarcation material (e.g., orange construction fencing) is required to separate underlying contaminated soil from overlying cover.

The long-term monitoring program must verify that for soil/sediment with concentrations greater than the CULs, erosion is not occurring and is unlikely to occur in the future. If the supplemental evaluation indicates an erosion risk, a remedial action or SCM should be implemented to achieve the protectiveness goals of the RAOs.

The long-term performance monitoring requirement includes: (1) non-erodible river bank areas where soil/sediment exceeding RALs or the PTW threshold values in ROD Table 21 (**Table 1**) are remediated by capping; or (2) areas outside of the active remediation area where soil/sediment exceeds the CULs.

4.1.4 Habitat Obligations

Per requirements of ROD Section 14.2, such actions are to integrate the use of beach mix to manage the remediated areas and minimize adverse effects to critical habitat. The selection of a post-remediation cover is site-specific and determined through remedial design. Key factors to be considered include erosion resistance, river bank configuration, current and anticipated future land and waterway use, and minimization of adverse effects on riparian and in-river habitat.

Remedial design must take impacts to habitat into consideration. ROD Section 14.2.9.5 (EPA 2017) states, "*In an SMA, contaminated river banks will be remediated through this cleanup where they are contiguous with in-river contamination or where they pose a risk of recontamination to the Selected Remedy. These cleanups will be conducted in a manner that is compatible with the Selected Remedy and minimizes adverse impacts to riparian habitat, including minimizing both slope angle and the use of hardened banks.*" The remedial design must also minimize adverse impacts to shallow water, off-channel, and other habitat types. ROD Section 14.2.9.1 (EPA 2017) states, "*As part of the remedial design, EPA, in coordination with natural resource agencies and tribes, will determine what areas are considered in-river habitat areas and on the river bank for the purpose of complying with the Endangered Species Act (ESA) and Section 404 of the Clean Water Act (CWA). EPA will also determine what elevations and what substrate materials will be required for caps, ENR, or placement of backfill materials in any identified habitat area to minimize adverse impacts to the aquatic environment while ensuring that the material will remain in place.*"

4.1.5 Institutional Controls

Based upon the objectives of the remedial action and when soil/sediment is left in place at concentrations greater than the CULs, ICs can be implemented for non-erodible areas or for active remediation areas. ICs are defined in ROD Section 17 (EPA 2017) as "*Non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. ICs play an important role in site remedies because they reduce exposure to contamination by limiting land or resource use and guide human behavior at a site.*" For details, ROD Section 14.2.6 (EPA 2017) describes specific objectives and applications for various types of ICs and their role in the Selected Remedy. Coordination with the Oregon Department of State Lands and other landowners is needed to implement land use or access restrictions. Monitoring, including inspections, is required to ensure the remedy and land use restrictions are functioning as intended and must be evaluated in statutory five-year reviews.

4.2 River Banks Pending Characterization

River banks adjacent to an SMA, which are pending characterization, are to follow the CERCLA process, with EPA oversight and further characterization is required when needed based upon future response actions. The characterization process for this river bank category is to follow **Section 2** of this guidance. **Table 3** lists the river banks that might need further information to determine whether the river bank is contiguous with contaminated river sediment. For PHSS river banks listed in **Table 3**, decisions regarding the need for additional characterization and/or remediation are to be based upon the outcome of data collected in relation to one or more of the following situations: (1) a river bank sufficiency assessment as part of the remedial design; (2) characterization during the pre-design work of the adjacent SMA; or (3) actions related to the DEQ upland source control program and/or upland property land use decisions. If cleanup action is needed following chemical and physical characterization, implementation of the action is to follow the process outlined for ROD river banks in **Section 4.1**.

5.0 References

ASTM International (ASTM). ASTM D2488. "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)". DOI: 10.1520/ D2488–09A. West Conshohocken, PA.

Bigham, K.A. 2011. "Evaluation and Application of the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) Model Developed to Predict Annual Streambank Erosion Rates." Master's Thesis.

Ecology and Environment. 2002. *McCormick and Baxter Sediment Cap Basis of Design*. Prepared for the Oregon Department of Environmental Quality.

Interstate Technology & Regulatory Council. "Incremental Sampling Methodology. Technical and Regulatory Guidance." Prepared by the Interstate Technology and Regulatory Council Incremental Sampling Methodology Team. February 2012.

Oregon Department of Environmental Quality (DEQ). 2016. "Portland Harbor Upland Source Control Summary Report". Updated March 25, 2016.

DEQ. . 2014. "Contaminant Delineation for Cleanup Projects. Land Quality Division Cleanup Program Internal Management Directive". Prepared by the Cleanup Program Development Team: Annette Dietz, Chuck Harman, Mark Pugh, Norm Read, Bob Schwartz. Reviewed by Bruce Gilles, Keith Johnson, Kevin Parrett, Max Rosenberg, Cheyenne Chapman. Last updated January 16, 2014.

Oregon Department of Environmental Quality (DEQ) and U.S. Environmental Protection Agency (EPA). 2005. "Portland Harbor Joint Source Control Strategy." December 2005.

Rosgen, D.L. 2009. "Watershed Assessment of River Stability and Sediment Supply (WARSSS) (second edition 2009)." Fort Collins, CO: Wildland Hydrology.

Rosgen, D.L. 2001. "A Practical Method Of Computing Streambank Erosion Rate." Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, No. 2.: pp. 9–15.

Starr, R. 2013. "Maryland Trust Fund Geomorphic Monitoring." Presentation by U.S. Fish and Wildlife Services, Chesapeake Field Office http://dnr.maryland.gov/streams/Documents/2013TFTraining_BANCS_Davis.pdf.

U.S. Army Corps of Engineers (USACE). 2014. "Portland-Vancouver Harbor Information Package, third edition." Published by Reservoir Regulator and Water Quality Section, USACE Portland District, October 2014.

U.S. Environmental Protection Agency (EPA). 2017. "Portland Harbor Superfund Site Record of Decision."

______. 2016a. Final Remedial Investigation Report, Portland Harbor RI/FS. U.S. Environmental Protection Agency Region 10, Seattle, WA.

______. 2016b. Feasibility Study, Portland Harbor RI/FS. U.S. Environmental Protection Agency Region 10, Seattle, WA.

______. 2002. Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan. Publication EPA QA/G-5S December 2002.

______ 2001. Portland Harbor Superfund Site Memorandum of Understanding (MOU) Between EPA, DEQ, Tribes, and Natural Resource Trustees.

______. 2000. Data Quality Objectives Process for Hazardous Waste Site Investigations QA/G-4HW – Final. Publication EPA/600/R-00/007, January 2000.

______ 1993. Data Quality Objectives Process for Superfund: Interim Final Guidance. OSWER Publication 9355.9-01 EPA540-R-93-071, September 1993.

Figures

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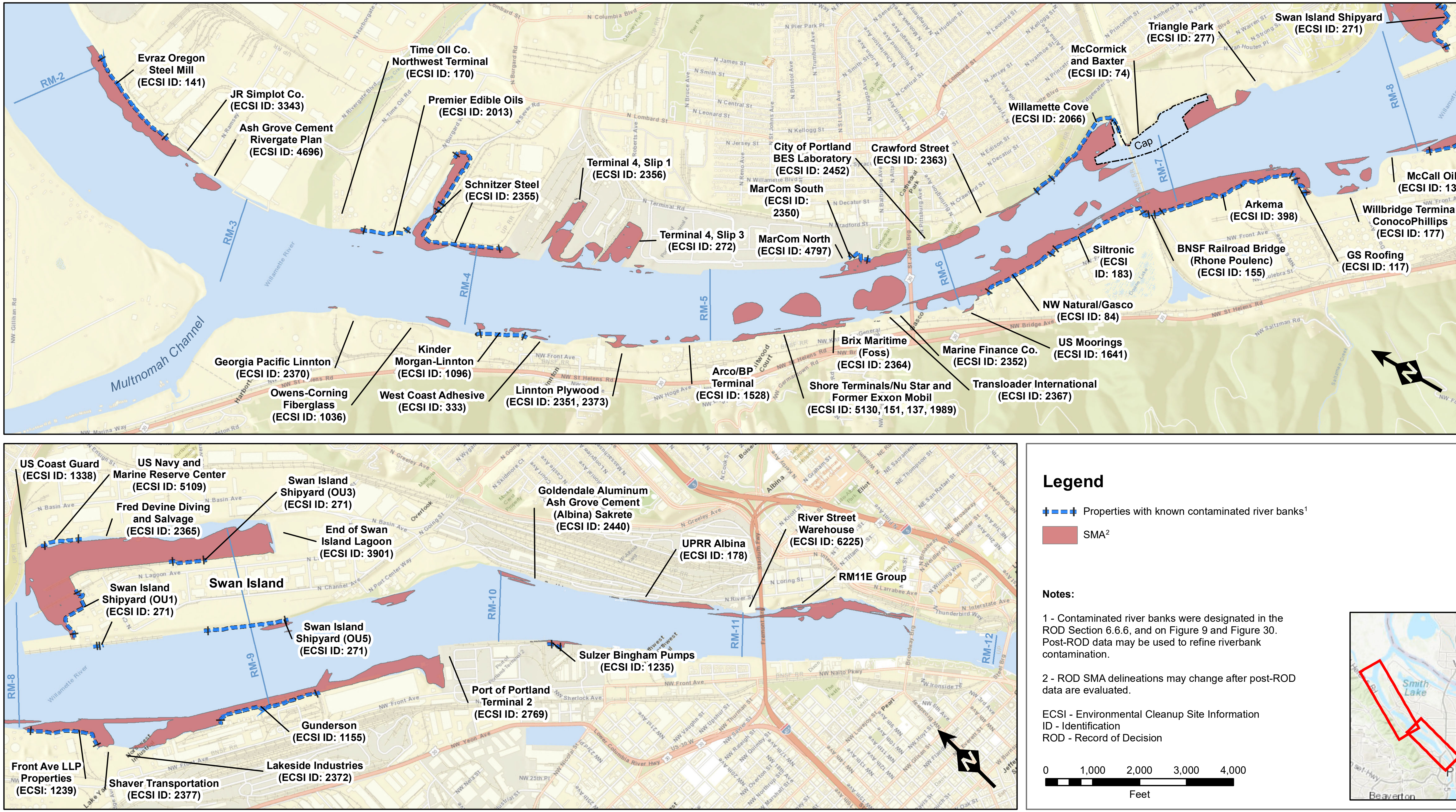

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Figure 1. Portland Harbor Superfund Site River Banks and Sediment Management Areas

Portland Harbor Superfund Site

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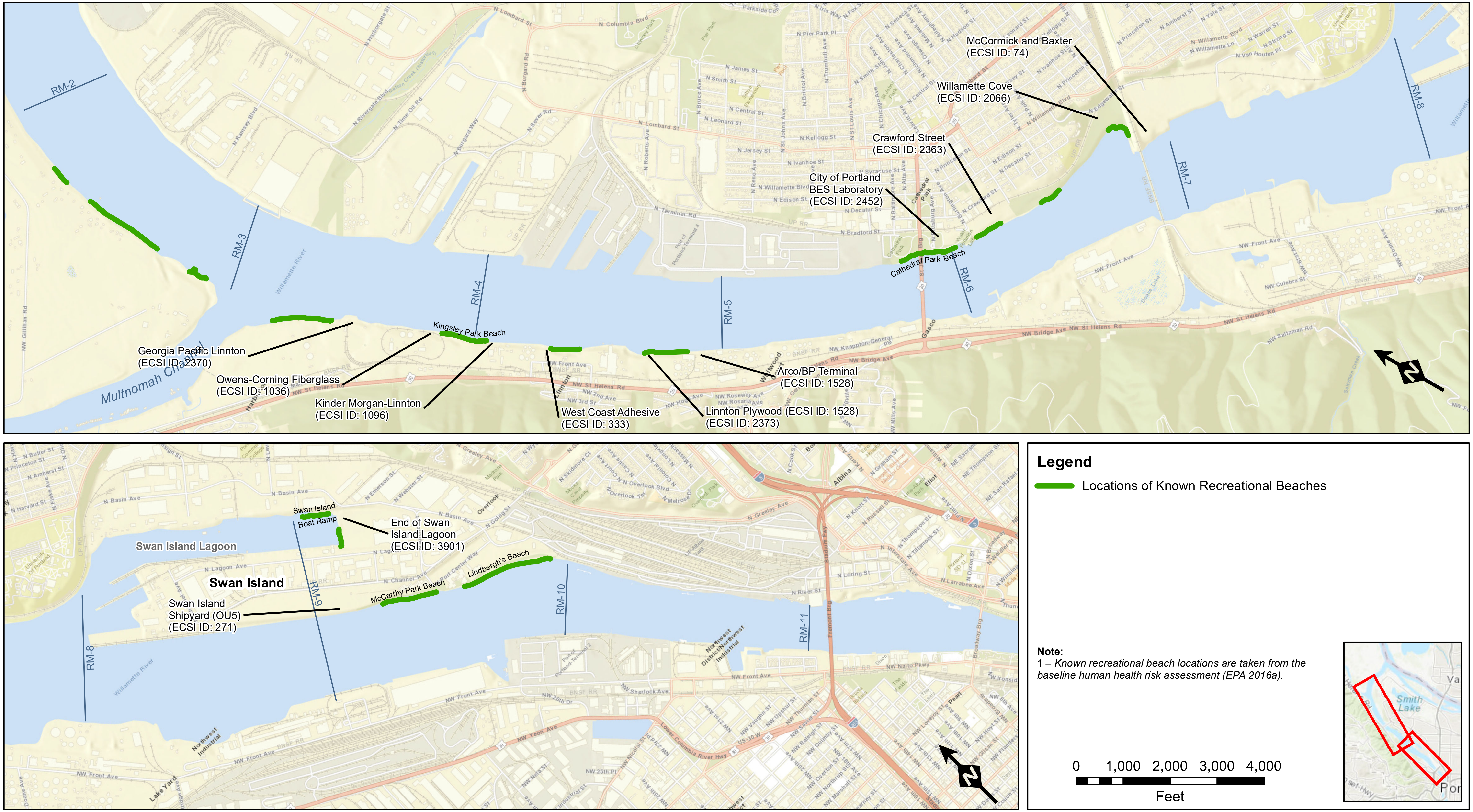

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Figure 2. River Banks with Recreational Beaches

Portland Harbor Superfund Site

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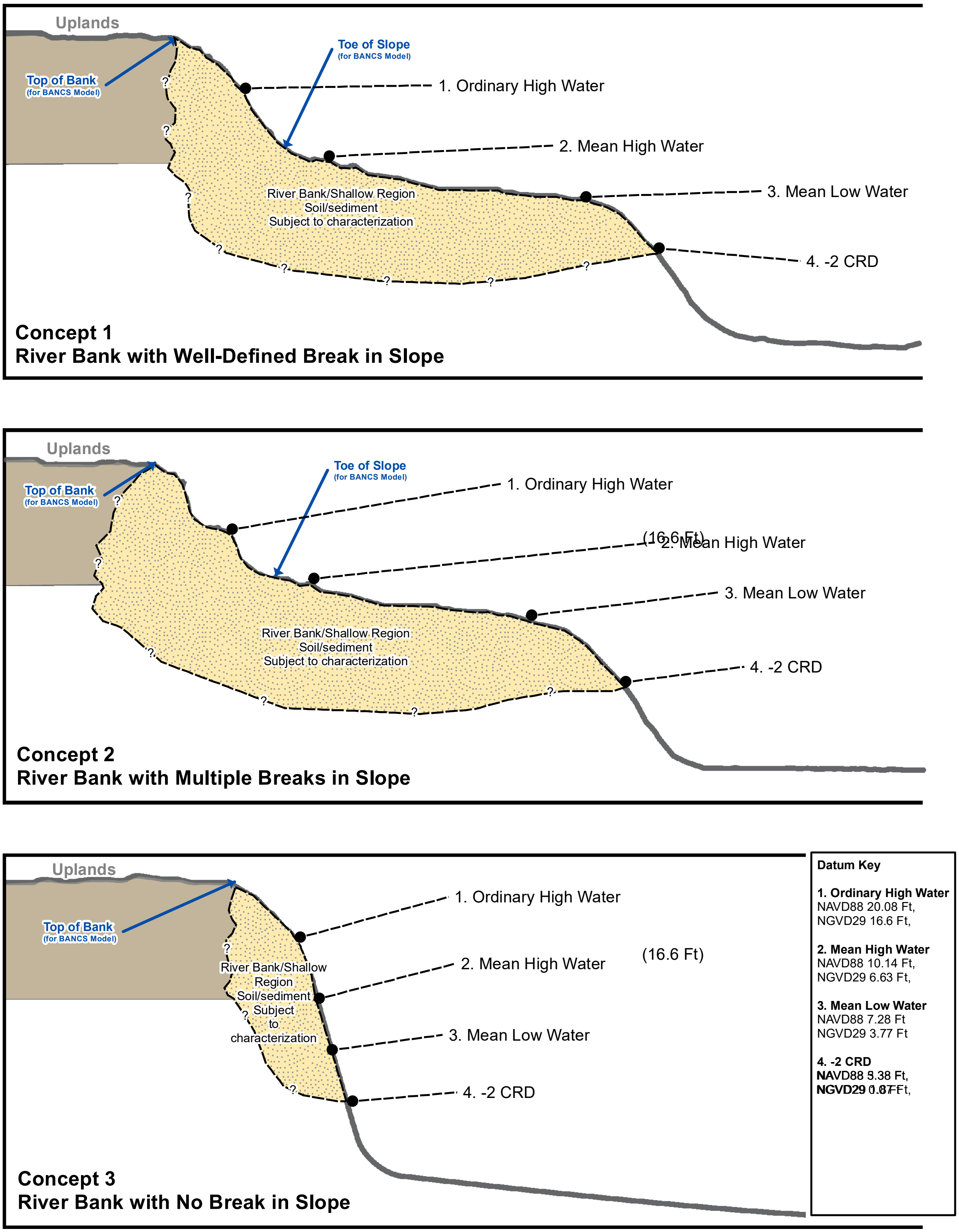

1. Conceptual river bank segments identify general spatial areas solely for planning and implementing data collection to meet river bank study objectives. River bank and shallow regions defined in the ROD (EPA 2017).
2. Water elevations are provided as reference and to aid characterization work on accessible areas of the river bank. See river bank guidance Section 2.
3. Geomorphic features, top of bank and toe of slope, are provided to support erodibility evaluations, See river bank guidance section 3.

Base elevation information is derived from the Morrison Street Bridge (NOAA Station ID: 9439221, Portland Morrison Street Bridge, OR) Portland, Oregon. Elevations are NAVD88 Datum, Units Feet. Source URL for Tidal Bench Marks: https://tidesandcurrents.noaa.gov/benchmarks.html?id=9439221

Ordinary High Water elevation from U.S. Army Corps of Engineers (USACE). 2014. Portland-Vancouver Harbor Information Package, Third Edition. Published by Reservoir Regulator and Water Quality Section, USACE Portland District, October 2014

CRD = Columbia River Datum   NAVD88 = North American Vertical Datum of 1988   NGVD29 = National Geodetic Vertical Datum of 1929

Figure 3. River Bank Conceptual Diagrams

Portland Harbor Superfund Site

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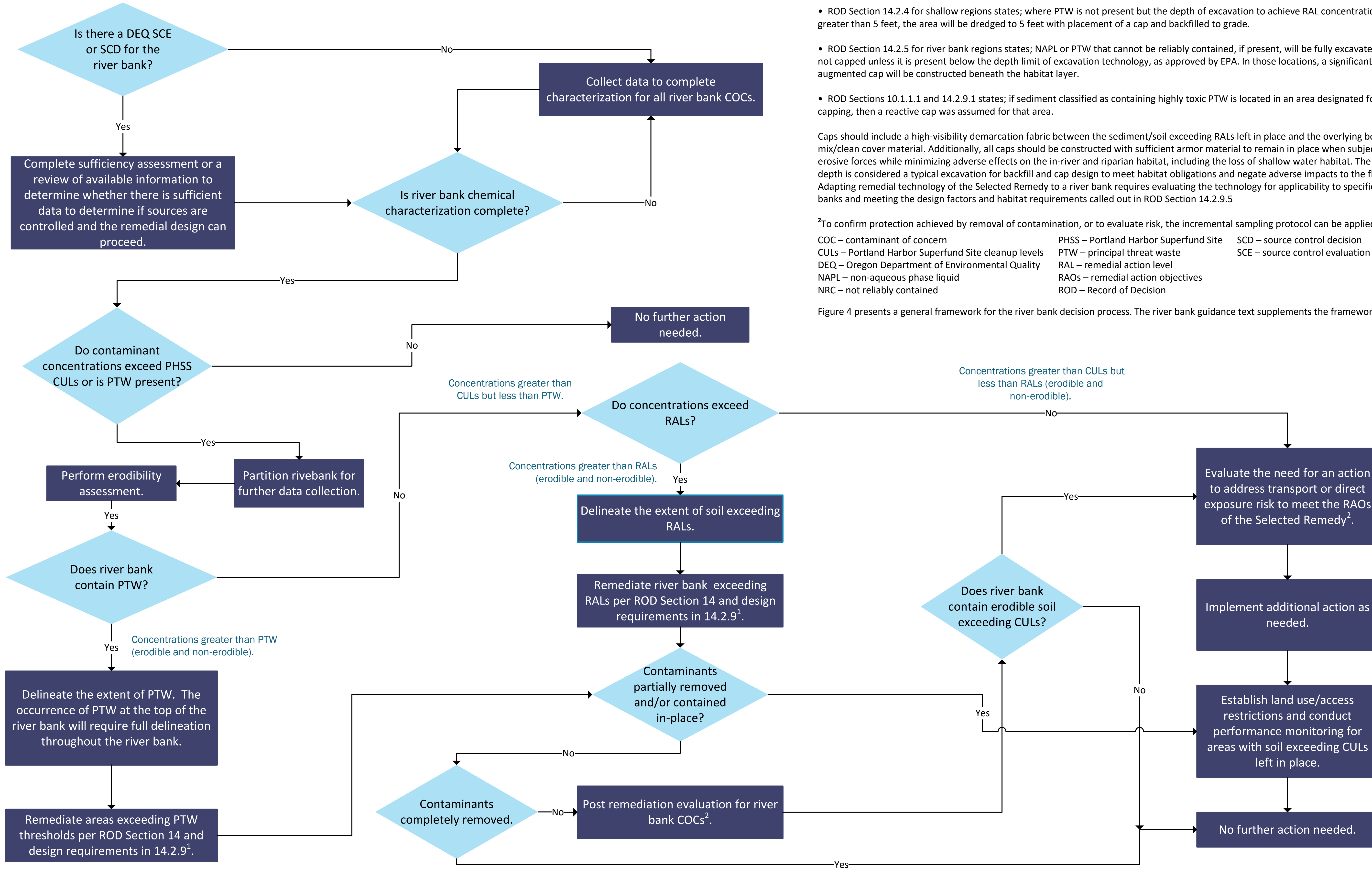

- ROD Section 14.2.4 for shallow regions states; where PTW is not present but the depth of excavation to achieve RAL concentrations is greater than 5 feet, the area will be dredged to 5 feet with placement of a cap and backfilled to grade.

- ROD Section 14.2.5 for river bank regions states; NAPL or PTW that cannot be reliably contained, if present, will be fully excavated and not capped unless it is present below the depth limit of excavation technology, as approved by EPA. In those locations, a significantly augmented cap will be constructed beneath the habitat layer.

- ROD Sections 10.1.1.1 and 14.2.9.1 states; if sediment classified as containing highly toxic PTW is located in an area designated for capping, then a reactive cap was assumed for that area.

Caps should include a high-visibility demarcation fabric between the sediment/soil exceeding RALs left in place and the overlying beach mix/clean cover material. Additionally, all caps should be constructed with sufficient armor material to remain in place when subject to erosive forces while minimizing adverse effects on the in-river and riparian habitat, including the loss of shallow water habitat. The five foot depth is considered a typical excavation for backfill and cap design to meet habitat obligations and negate adverse impacts to the floodway. Adapting remedial technology of the Selected Remedy to a river bank requires evaluating the technology for applicability to specific river banks and meeting the design factors and habitat requirements called out in ROD Section 14.2.9.5

[2]To confirm protection achieved by removal of contamination, or to evaluate risk, the incremental sampling protocol can be applied.

COC – contaminant of concern
CULs – Portland Harbor Superfund Site cleanup levels
DEQ – Oregon Department of Environmental Quality
NAPL – non-aqueous phase liquid
NRC – not reliably contained
PHSS – Portland Harbor Superfund Site
PTW – principal threat waste
RAL – remedial action level
RAOs – remedial action objectives
ROD – Record of Decision
SCD – source control decision
SCE – source control evaluation

Figure 4 presents a general framework for the river bank decision process. The river bank guidance text supplements the framework.

Figure 4. Decision Guide for Characterizing and Implementing Remedial Action for ROD River Banks

Portland Harbor Superfund Site

Tables

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Table 1
Cleanup Criteria, Remedial Action Levels and Threshold Values Adapted from the Portland Harbor Superfund Site ROD Tables 17 and 21

Contaminants	Site Wide Remedial Action Levels (RALs)[1]	Principal Threat Wastes Thresholds (PTW)[2]	Cleanup Levels (CULs) RAO 9*	Basis of CUL
Focused COCs	µg/kg	µg/kg	µg/kg	
PCBs	75	200	9	B
Total PAHs [4]	30,000	NA	23,000	E
2,3,7,8-TCDD	0.0006	0.01	0.0002	B
1,2,3,7,8-PeCDD	0.0008	0.01	0.0002	B
2,3,4,7,8-PeCDF	0.2	0.2	0.0003	B
DDx	160	7,050	6.1	R**
Additional Contaminants				
2,3,7,8-TCDF	NA	0.6	0.0004	R**
1,2,3,4,7,8-HxCDF	NA	0.04	0.0004	B
cPAHs (BaP Eq) [3]	NA	774,000	85	R[3]
Chlorobenzene	NA	>320	--	
Naphthalene	NA	>140,000	--	
Table 17 CUL for RAO 9 River Bank Soil and Sediment* (µg/kg unless otherwise noted)				
Aldrin			2	R
Arsenic			3 mg/kg	B
BEHP			135	E**
Cadmium			0.51 mg/kg	E
Chlordane			1.4	E
Copper			359 mg/kg	E
DDD			114	E
DDE			226	E**
DDT			246	E
Dieldrin			0.07	R**
Lindane			5	E
Lead			196 mg/kg	E
Mercury			0.085 mg/kg	E
TPH diesel			91 mg/kg	E
Tributyltin			3080	E
Zinc			459 mg/kg	E

*RAO 9 CULs for river bank soil/sediment were selected to be protective of all receptors and meet objectives of RAOs 1, 2, 5, and 6 by selecting the more protective concentration, or the background value if the protective value was lower than the background (See ROD Section 9.1).
** CUL derived from food web model as protective for human and ecological receptors. See ROD Sections 9.1.1 and 9.1.2.
COCs - contaminants of concern

PTW - principal threat wastes, see ROD Section 6.5.1 and definition in the River Bank Guidance Appendix A Glossary.

R = Human health based criteria; E = Ecological effects based criteria; B = Background for the PHSS

1 – Site wide includes all areas of the Site except the navigation channel. FMD (future maintenance dredge) areas are subject to these RALs.

2 – PTW threshold values are based upon highly toxic PTW values (10^{-3} risk) except chlorobenzene and naphthalene, which are threshold values for not reliably contained PTW.

3 – The cleanup level for cPAHs of 85 µg/kg is based on recreational beach exposure. The cleanup level applicable to the navigation channel is 1076 µg/kg and is based on human consumption of clams. The cleanup level of 774 µg/kg is based on direct contact with sediment and is applicable to nearshore sediment exclusive of beaches and navigation channel sediments.

4 – Total PAH is calculated as the sum of LPAH and HPAH.
LPAH (low molecular weight PAH) is calculated as the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.

HPAH (high molecular weight PAH) is calculated as the sum of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

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Table 2
Record of Decision River Banks
Portland Harbor Superfund Site

Site Name or Identifying Address	Willamette River Mile	Environmental Cleanup Site Information Number
East Side of Willamette River		
Evraz Oregon Steel Mill	2E	141
Premier Edible Oils	3.5E	2013
Schnitzer Steel Industries	3.8E	2355
MarCom South	5.6E	2350
Willamette Cove	6.8E	2066
McCormick and Baxter EPA-led site completed with a separate record of decision.	7E	74
U.S. Navy and Marine Reserve Center (SIL)	8.2E	5109
Swan Island Shipyards (OUs 1, 3, and 5)	8.5E	271
West Side of Willamette River		
Kinder Morgan Linnton Bulk Terminal	4.2W	1096
NW Natural/Gasco	6.3W	84
Siltronic	6.6W	183
BNSF Railroad Bridge (related to contamination from the Arkema and Rhone-Poulenc Sites)	7W	398, 155
Arkema	7.2W	398
GS Roofing	7.5W	117
Front Ave LLP Properties (Glacier NW Inc., Hampton Lumber, Tube Forgings)	8.2W	1239, 2378, 5761
Gunderson	9W	1155
Sulzer Bingham Pumps	10.2W	1235

Notes:
River banks are identified in Section 6.6.6 and/or Figure 9 of the Portland Harbor Superfund Site Record of Decision, and mapped on Figure 1 of the river bank guidance.
DEQ - Oregon Department of Environmental Quality
ECSI - Environmental Cleanup Site Information
SIL - Swan Island Lagoon

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Table 3
Remedial Action River Banks Pending Contaminant Delineation
Portland Harbor Superfund Site

Site Name or Identifying Address	Willamette River Mile	Environmental Cleanup Site Information Number
East Side of Willamette River		
JR Simplot (Former Unocal)[2]	2.6E	3343
Ash Grove Lime (Rivergate)[2]	2.8E	4696
Time Oil Northwest Terminal [2]	3.5E	170
Terminal 4 - Slip 1[2]	4.3E	2356
Terminal 4 - Slip 3[2]	4.6E	272
MarCom North[2]	5.5E	4797
City of Portland BES Laboratory [2]	6E	2452
Crawford Street[2]	6.3E	2363
Triangle Park[2] EPA-led site; separate record of decision.	7.5E	277
U.S. Coast Guard Marine Safety Unit [2]	8.1E	1338
Fred Devine Diving and Salvage[2] (SIL)	8.4E	2365
End of Swan Island Lagoon[2] (SIL)	9E	3901
Goldendale Aluminum[2] Ash Grove Cement (Albina)[2]	10.1E	2440
UPRR Albina[2]	10.8E	178
Sakrete [1]	10.9E	--
River Street Warehouse (Stan Herman) [1]	11E	6225
Oregon Department of Transportation (beneath Fremont Bridge) [1]	11E	5437
Ross Island Sand and Gravel [1]	11.1E	5577, 5860
Glacier NW, Inc.[1]	11.2E	5449, 5860
Unkeles Family, LLC [1]	11.3E	--
Cargill, Inc.[1]	11.6E	5561, 5860

Site Name or Identifying Address	Willamette River Mile	Environmental Cleanup Site Information Number
West Side of Willamette River		
Georgia Pacific Linnton[2]	3.5W	2370
Owens-Corning Fiberglass[2]	3.8W	1036
West Coast Adhesive Company [2]	4.4W	333
Linnton Plywood[2]	4.5W	2351, 2373
Arco/BP Terminal[2]	4.8W	1528
Shore Terminals/NuStar[2] and former ExxonMobil (ECSI # 151)	5.3W	5130, 151, 137, 1989
Brix Maritime (Foss)[2]	5.5W	2364
Transloader International Company [2]	5.6W	2367
Marine Finance[2]	5.7W	2352
US Moorings[2]	6W	1641
Willbridge Terminal [2] ConocoPhillips	7.7W	177
McCall Oil[2]	8W	134
Shaver Transportation Company [2]	8.4W	2377
Lakeside Industries[2]	8.5W	2372
Port of Portland Terminal 2 [2]	9.8W	2769

Notes:

[1] These sites have river banks that are within the area associated with the RM11E Group. EPA entered into an Administrative Order on Consent (AOC) in April 2013 with the River Mile 11E Group that includes: Cal/Portland (formerly Glacier NW), Cargill, Inc., CBS Corporation, City of Portland, DIL Trust, and PacifiCorp.

[2] River bank property adjacent to a sediment management area (SMA) and mapped on Figure 1 of the river bank guidance. These river banks areas are subject to change based on potential changes to SMA delineation during remedial design or data collected in an upland activity.

DEQ - Oregon Department of Environmental Quality

SIL - Swan Island Lagoon

Appendix A - Glossary of Terms

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Appendix A - Glossary and Definitions

Active Remedy, Active Remedy Component, or Active Remediation: Comprises a cleanup action that has been chosen through the remedy selection process, documented in the ROD, and involves design, construction, and maintenance, with monitoring to ensure the integrity of the constructed remedy remains effective. PHSS ROD Section 14.2.7 refers specifically to active remediation activities as dredging, capping, and placement of clean sediment for ENR.

Armoring: The practice of using material such as gravel or rocks to protect riverbanks or caps from erosion.

Bank Angle: River bank slope is measured from the toe of the slope to the top of the bank. The maximum slope of the river bank between the toe of the slope and top of the bank must be used in the erodibility assessment because it is the condition most prone to erosion or failure. The slope can be determined from topographic or bathymetric maps or measured in the field using a clinometer or other suitable direct field measurement technique.

Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) Model: An empirically derived model developed for a specific hydro physiographic region to rapidly estimate sediment yield from streambank erosion, based on both physical and observational measurements of a streambank.

Bank Composition: The soil types that comprises the river bank.

Bank Erosion Hazard Index (BEHI): A parameter for assessing river bank characteristics and erosion potential. BEHI was developed by Dave Rosgen (2001).

Bank Erosion Rate (BER): The rate of river bank erosion in feet per year.

Bank Material Stratification: River bank soil existing in layers with various soil textures, permeability, and cohesion.

Bankfull Level: Bankfull level is the point on the river bank that contains normal nonflood-level flows of the river throughout the year and is typically identifiable by visible changes in topography, vegetation type, or sediment grain size. At PHSS, based upon Willamette River gauging data, bankfull can be approximated by the OHW elevation of 20.08 feet (NAVD 88) as calculated from data in the USACE Portland Harbor hydrology document (2014).

Beach Mix: A mix of sand, gravel, and inorganic material used for anchoring caps to prevent erosion. This material mimics previous habitat material.

Cap Amendments: Material such as organoclay or activated carbon, added to caps to enhance performance in isolating and containing contaminants.

Cleanup: Actions taken to address a release or threatened release of hazardous substances or pollutants and contaminants that may affect public health or the environment. Agencies often use the term broadly to describe various response actions or phases of remedial activities, such as a remedial investigation/feasibility study. “Cleanup” is sometimes used interchangeably with the terms “remedial action,” “remediation,” “removal action,” “response action,” or “corrective action.”

Cleanup Level: Residual concentration of a hazardous substance determined to be protective of public health, safety and welfare, and the environment under specified exposure conditions.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): This law, enacted by Congress on December 11, 1980, created the Superfund program. Specifically, CERCLA: (1) established prohibitions and requirements concerning the assessment, investigation, and remediation of hazardous waste sites; (2) provided for liability of persons responsible for releases of hazardous waste at these sites; and (3) established a trust fund to provide for cleanup when no responsible party could be identified. CERCLA was amended by the Superfund Amendments and Reauthorization Act of 1986.

Conceptual Site Model: A written description and illustration of predicted relationships between receptors (both human and ecological) and the hazardous substances they may be exposed to.

Contaminant of concern (COC): Contaminants that pose an unacceptable risk to human health and the environment, as identified in the risk assessments.

Columbia River Datum (CRD): Is the plane of reference from which river stage is measured on the Columbia River from the lower Columbia River up to Bonneville Dam and on the Willamette River up to Willamette Falls. Equals 1.82 feet above mean sea level (equivalent to National Geodetic Vertical Datum of 1929) at Vancouver, Washington.

Endangered Species Act (ESA): Federal statute enacted in 1973 to conserve species and ecosystems. Species facing possible extinction are listed as “threatened” or “endangered” or as “candidate” species for such listings. Following such a listing, recovery and conservation plans are put in place to protect the species and its habitat.

Enhanced Natural Recovery (ENR): Accelerating the natural recovery process by adding a thin layer cover of clean sand over contaminated sediment.

Erosion: The action of surface processes (such as water flow or wind) that remove soil, rock, or dissolved material from one location on the Earth's crust then transport it away to another location.

Feasibility Study (FS): An assessment of cleanup alternatives. A feasibility study, or FS, is conducted if the risk assessment performed during a remedial investigation establishes the presence of unacceptable risks. During an FS, EPA screens and evaluates alternatives to clean up a site based on nine evaluative criteria, including effectiveness, cost and community acceptance.

Five-year review: Pursuant to CERCLA a five-year review is a statutory requirement if the remedial action results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. This review evaluates whether such a remedy is protective of human health and the environment and is required to be completed no less often than every 5 years after the start of the cleanup (National Contingency Plan [NCP] § 300.430(f)(4)(ii)).

Focused COC: A subset of the PHSS COCs with concentrations of the most widespread contaminants and those that pose the greatest risks. The focused COCs are used only for the development of SMAs and to develop RALs.

Height of Bank: River bank height, as measured from the top of the bank to the toe of the slope, must be determined from topographic and bathymetric maps or measured in the field using survey methods.

Institutional Control (IC): Non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Although it is EPA's expectation that treatment or engineering control will be used to address principal threat wastes and that groundwater will be returned to its beneficial use whenever practicable, ICs play an important role in site remedies because they reduce exposure to contamination by limiting land or resource use and guide human behavior at a site.

In-river: The proposed action will address contaminated sediment, river banks, groundwater, and surface water in a portion of the Portland Harbor Superfund Site. The upland portion will be addressed by DEQ.

Leave Surface: The surface of soil left in place upon completion of excavation being performed as part of a remedial action. Commonly used terminology for dredging operations. The term is synonymous with floor or sidewall samples in an excavation.

Mean High Water (MHW): The tidal datum that is the average of all the high water heights observed over the National Tidal Datum Epoch. Elevations of MHW at Portland Harbor are derived from the Morrison Street Bridge (NOAA Station ID: 9439221, Portland Morrison Street Bridge, OR) Portland, Oregon. The Source URL for the Tidal references is: https://tidesandcurrents.noaa.gov/benchmarks.html?id=9439221.

Mean Low Water (MLW): The tidal datum that is the average of all the low water heights observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made to derive the equivalent datum of the National Tidal Datum Epoch. Elevations of MLW at Portland Harbor are derived from the Morrison Street Bridge (NOAA Station ID: 9439221, Portland Morrison Street Bridge, OR) Portland, Oregon. The Source URL for the Tidal references is: https://tidesandcurrents.noaa.gov/benchmarks.html?id=9439221.

Monitored Natural Recovery (MNR): A risk reduction approach for contaminated sediment that uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment.

Near Bank Stress (NBS): Erosional forces of the river acting on the river bank.

Nearshore: Relating to or denoting the region of the river or riverbed relatively close to the shoreline.

Nonaqueous phase liquid (NAPL): Material that is not soluble in water.

North American Vertical Datum of 1988 (NAVD 88): A fixed reference for elevations determined by geodetic leveling. The datum was derived from a general adjustment of the first-order terrestrial leveling nets of the United States, Canada, and Mexico.

Ordinary High Water (OHW): Water level (in feet) established by field observation of seasonally high river levels by USACE. Ordinary high water designates the jurisdictional limits of the structures and/or work affecting all A-2 navigable rivers, including the Columbia and Willamette Rivers. Ordinary high water in both stage and elevation for the Columbia and Willamette Rivers is provided by river mile in Tables A-1 and A-2. (USACE 2014). Elevation of OHW at Portland Harbor was obtained from the U.S. Army Corps of Engineers (USACE). 2014. *Portland-Vancouver Harbor Information Package, Third Edition.* Published by Reservoir Regulator and Water Quality Section, USACE Portland District, October 2014.

Principal Threat Waste (PTW): Defined as source material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air or that acts as a source for direct exposure. Further, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. PHSS ROD Section 6.5.1 provides details for specific chemicals and categories of PTW that are addressed by the Selected Remedy. Within PHSS, areas with PTW will be addressed by active remediation, not MNR.

Record of Decision (ROD): The document issued by EPA that documents site investigations, evaluation of human health and ecological risks, and evaluation of remedial alternatives. It describes the Selected Remedy to clean up a Superfund site.

Remedial Action Level (RAL): RALs are a range of contaminant concentrations that are less than the current sitewide surface weighted average concentrations (SWACs) and greater than the preliminary remediation goals. At this site, RALs are contaminant-specific sediment concentrations used to identify areas where capping and/or dredging will be assigned and thus are the basis of the SMA boundaries or footprints. RALs are contaminant-specific sediment concentrations of focused contaminants of concern (COCs) used to define areas for more active cleanup that will reduce contaminant concentrations and risks more effectively than ENR or MNR from current sitewide average concentrations.

Remedial Action Objective (RAO): Media-specific goals that remedial alternatives/remedies need to achieve for protecting human health and the environment.

Response Action: The phrase used to describe any and all “actions” as either studies, investigations, decisions, designs, or constructions that are conducted with CERCLA authority. CERCLA section 104 provides broad authority for a federal program to respond to releases of hazardous substances and pollutants or contaminants. There are two major types of response actions: the first is "removal action," the second is "remedial action." PHSS has completed a remedial decision with a Selected Remedy, as documented in the Record of Decision January 2017, PHSS is now in the response action phase for pre-remedial data collection, design, and implementation of remedial actions.

River Bank Region: Defined in ROD Section 6.5.2 (and 6.6.6) as areas from top of bank down to the river that may be contaminated along the shoreline next to contaminated in-river shallow areas (Shallow Region).

Root Density: The proportion of the river bank covered by plant roots, expressed as a percent.

Rooting Depth: The maximum depth of plant roots in the river bank.

Sediment Management Areas (SMAs): Areas delineated by RALs where containment or removal technologies will be considered to immediately reduce risks upon implementation.

Shallow Region: Defined in ROD Section 14.2.4 as the area shoreward of the river bed elevation of approximately **-**2 feet Columbia River Datum (CRD). In this region, avoiding or minimizing impacts to the aquatic environment and floodway need to be considered and evaluated to meet CWA (Section 404) and federal floodway requirements as well as climate change impacts.

Source Control: Actions that prevent or reduce migration of contamination to environmental media through removal, containment, or treatment.

Source Material: Material that includes or contains hazardous substances, pollutants, or contaminants that acts as a reservoir for migration of contamination to groundwater, surface water, sediment, or air or that acts as a source for direct exposure.

Stage: The level of the river at a point in time.

Stream Velocity: The velocity of moving water in the river at a specific location and depth in the water column.

Surface Protection: The amount of streambank covered and protected by woody debris, rooted vegetation, embedded boulders, revetment, bedrock, or other embedded materials that protect the streambank from erosion.

Sufficiency Assessment: Assessment conducted during remedial design to evaluate whether potential sources of recontamination have been adequately investigated and controlled or considered such that remedial action can proceed. The Sufficiency Assessment will consider whether potential recontamination from upland (direct discharges, groundwater, riverbank, overwater) and in-water sources will adversely impact the short- or long-term effectiveness of the proposed remedial action.

Top of Bank: The top of the river bank is defined as the point where the slope of the land surface changes from toward the river to toward the uplands.

Uplands: The portion of PHSS that includes the sources of contamination to the river, such as upland facilities. The uplands are being addressed by DEQ.

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Appendix B

Portland Harbor Draft Model Sufficiency Assessment Language
(June 14, 2019)

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Portland Harbor Draft Model Sufficiency Assessment Language (6/14/2019)

1.1 Sufficiency Assessment. The Portland Harbor ROD Section 14.2.11 states that implementation of the Selected Remedy may need to be conducted in phases and/or work sequenced based on consideration of a range of factors including source control actions and recontamination potential. To evaluate source control actions and recontamination potential, a Sufficiency Assessment Report shall be submitted to EPA for comment and approval.

The objective of the Sufficiency Assessment is to evaluate upland (direct discharges, groundwater, river bank, overwater) and in-water sources of contaminants to determine whether they have been adequately investigated and sufficiently controlled or considered such that the RA can proceed. The Sufficiency Assessment will consider whether upland (direct discharges, groundwater, river bank, overwater) and in-water sources will adversely impact the short- or long-term effectiveness of the proposed RA. The Sufficiency Assessment should be completed following the schedule deadlines in Section 6.2.

(a) The Sufficiency Assessment shall consider potential impacts from a range of potential sources, including but not limited to:

(1) Upland pathways (direct discharges, groundwater, river bank, and overwater);

(2) In-water sources of recontamination;

(3) Resuspension of sediments from natural and anthropogenic activities;

(4) Factors that may impact sediment cap effectiveness;

(5) Potential future use for near shore land and in-water uses; and

(6) Other future conditions (e.g., climate change impacts) that may impact recontamination potential.

(b) The components of the Sufficiency Assessment Report shall include:

(1) Description of the Project Area setting, the upland and in-water source areas being evaluated and an overview of the remainder of the report.

(2) A CSM that describes the geographically relevant upland (direct discharges, groundwater, river bank, and overwater) and in-water sources of contamination, contaminants of concern (COCs) and migration pathways into the Project Area.

(3) A summary of available information regarding the source control status of direct discharges, groundwater, river bank, and overwater sources of

COCs into the Project Area that may affect achieving any of the remedial action objectives by comparing to ROD Table 17 cleanup levels and Table 21 RALs and PTW thresholds as one line of evidence; identification of any sources, COCs and pathways that have not been effectively addressed and could impact the RA; and identification of data gaps.

(4) A summary of in-water sources of COCs to the Project Area that may affect achieving any of the remedial action objectives. One line of evidence in this evaluation will be comparing to ROD Table 17 cleanup levels and Table 21 RALs and PTW Thresholds including a description of any proposed measures to address in-water sources including the timing and expected effectiveness of these measures.

(5) An assessment of the degree to which the proposed remedy will address upland (direct discharges, overwater, groundwater, and river bank) and in-water sources of COCs to the Project Area.

(6) An assessment of the degree to which changed future conditions (e.g., changes in land and waterway use and climate change) may affect recontamination potential at the Project Area.

(7) The results of the Sufficiency Assessment that includes evaluation of the sufficiency of upland and in-water source controls to reduce the potential for recontaminating the selected remedy following implementation. The assessment will consider the general magnitude of any potential recontamination effects and discuss implications to the selected remedy for the Project Area. The discussion will also present the limitations of the assessment approaches and any remaining data gaps.

(8) A sufficiency assessment summary table of upland sources (direct discharges, overwater, river bank) that explicitly identifies the potential sources and pathways at the Project Area and categorizes the status of each source using the outcome categories: (A) sources are sufficiently controlled; (B) sources are conditionally controlled; and (C) sources are not sufficiently assessed or controlled. An example table is provided in Attachment 3 of the SOW. Completing the sufficiency assessment summary table is a valuable exercise to ensure that there is consensus on the status of potential sources at the Project Area. The goal of this table is to serve as the basis for EPA's sufficiency determination in informing respondents whether cleanup can go forward and, if potential sources remain, how those sources should be integrated into the in-water design. The sufficiency assessment summary table shall be updated and included in the Pre-Final (95%) RD as a final check to ensure remedial construction can commence.

(9) Description of how data gaps, if any, will be addressed.

(10) Conclusions and Recommendations. The Sufficiency Assessment Report shall present conclusions and recommendations. Recommendations will be expressed as one of three potential outcomes:

(i) Sources are sufficiently controlled: the report recommends the specified area of sediment cleanup proceed based on reasonable confidence that the relevant recontamination potential is as minimal as possible.

(ii) Sources are conditionally controlled: the report recommends the specified area of sediment cleanup proceed so long as certain additional controls or oversight are implemented in a reasonable timeframe or that any area information gaps are considered.

(iii) Sources are not sufficiently assessed or controlled: the report recommends that specified area of sediment cleanup not proceed until additional controls have been implemented and assessed for effectiveness.

(11) References section listing each document cited in the report

(c) The Sufficiency Assessment does not itself satisfy the requirements of the federal Clean Water Act, CERCLA or other authorities. For example, a site or area that has been evaluated for source control sufficiency for the in-water RA may still be required to take additional measures to meet water quality permit or upland cleanup requirements.

Following remedy implementation, post-construction monitoring will be performed to evaluate remedy effectiveness. Post-construction monitoring will be designed to distinguish between recontamination and assessing whether the remedy is functioning as intended to demonstrate long-term performance of the remedy across appropriate temporal and spatial scales.

Appendix E

Example Sufficiency Assessment Table

Site	ECSI #	Pathway(s)	Status	Sufficiency Assessment Contaminants	Milestone Document	Remedial Design/Source Control Task
Pacificorp-Albina Riverlots	5117	NA	A	NA	Source Control Decision, July 14 2017	NA
PacifiCorp-Knott Substation	5117	NA	A	NA	Source Control Decision, April 5 2013	NA
Tarr Inc.	1139	GW	B	Chlorinated VOCs	Record of Decision, July 17, 2017	DEQ ROD requires source area treatment and performance monitoring for groundwater pathway.
Glacier NW	5449	SW	B	BEHP	Source Control Measures Implementation Report, Nov 2016	Additional stormwater source control measures and performance monitoring for BEHP continues. Recent source tracing results presented in a September 2018 letter report available on ECSI. Source not yet fully controlled.
Westinghouse	4497	GW, SW	A	NA	Source Control Report, April 2010	Draft source control decision in review
Cargill-Irving Grain Elevator (Temco)	5561	SW	B	Metals	Source Control Evaluation, July 2014	Stormwater controls are being evaluated through monitoring. Most recent sampling results presented in February 2018 stormwater sampling report available on ECSI.
Tucker Building	3036	NA	A	NA	Source Control Decision, July 2017	NA
Valvoline Inc.	3215	NA	A	NA	NA	Excluded for SCE – no source or incomplete pathway.
Master Chemical	1302	NA	A	NA	NA	Excluded for SCE – no source or incomplete pathway.
Ross Island Sand & Gravel	5577	RB	B	NA	Source Control Evaluation Letter, June 6 2011	DEQ/EPA to confirm riverbank erosion pathway not a concern, DEQ issued a site inspection request October 8, 2018.
Vermiculite Northwest (former) (WR Grace)	2761	NA	A	NA	NA	Excluded for SCE – no source or incomplete pathway.
Cascade Brake Products	1019	NA	A	NA	NA	Excluded for SCE – no source or incomplete pathway.
Campbell Dry Cleaner	5680	NA	A	NA	NFA Determination July 2016	Excluded for SCE – no source or incomplete pathway.
Kenton Foundry	5758	GW, SW	A	PCBs, metals	ICP Report, April 2015. Source Control Evaluation pending	Site is adjacent to Westinghouse, and as with that site has been subject to contaminant removal and redevelopment by City of Portland. Stormwater issues have been resolved, and groundwater data for Westinghouse are applicable to Kenton Foundry (no downgradient impacts). SCE and DEQ SCD pending.
UPRR Albina Yard – Outfall 45	178	SW	B	NA	-	SW discharge to the RM11E SMA from the UPRR Albina Yard is limited to a small parking area that drains to Outfall 45. Assigned low priority given the limited size and historical low concentrations. SCE work pending.

Site	ECSI #	Pathway(s)	Status	Sufficiency Assessment Contaminants	Milestone Document	Remedial Design/Source Control Task
Riverstreet Warehouse Fire (a.k.a. Stan Herman Site)	6225	RB	B	NA	EPA October 22, 2018 letter	Riverbank and upland capped by rock following EPA emergency response. EPA and DEQ concur that riverbank does not pose a recontamination risk, while the limited site upland is either paved or capped by rock.
ODOT/Stan Herman/KF Jacobson Lease	--	RB	C	PAHs associated with asphalt grindings	NA	DEQ working with ODOT to remove/contain asphalt grindings in “ramp area” jointly owned by ODOT and Stan Herman, and with ODOT on leaseholder (KF Jacobson) management of asphaltic material on ODOT property beneath the Fremont Bridge.
2100 N. Albina	6287	SW, GW	B	TPH, metals	Phase 1 ESA; December 2017	PPA signed with DEQ, source control related investigation in progress.
ODOT Fremont Bridge	5437	SW	B	Metals, PAHs, BEHP, PCBs, DDx	NA	Additional stormwater source control measures needed for Fremont Bridge scuppers and areas draining to outfall WR-306 and performance monitoring.
City of Portland	2425	SW	A	NA	City of Portland Effectiveness Monitoring Report July 2018	Source control decision pending.
Upriver	--	SD	B	PH COCs	NA	Site-wide baseline and long-term monitoring.
In-Water SMA	--	SD, PW, OW	C	PH Focused COCs	NA	Addressed during design.

Legend

Highlighting indicates sites for which source control decisions have been completed by DEQ.

All milestone documents are available on DEQ’s ECSI website.

(A) Sources are sufficiently controlled
(B) Sources are conditionally controlled
(C) Sources are not sufficiently assessed or controlled
NA = Not applicable, all pathway(s) excluded. GW = Groundwater
SW = Stormwater
RB = Riverbank erosion
SD = Sediment
PW = Porewater
OW = Overwater activities

Note: Table was developed by the Oregon Department of Environmental Quality

Appendix F

Remedial Design Frequent Comments

Appendix F (April 2021 Version)

Remedial Design Frequent Comments

This appendix provides a summary of U.S. Environmental Protection Agency (EPA) comments that are frequently provided to the performing parties during remedial design document reviews for the Portland Harbor Superfund Site (Site). The document types reviewed included the sufficiency assessment report (SAR), pre-design investigation (PDI) work plan (WP), and basis of design report (BODR). The EPA comments below are organized by best fit to a given topic, and sections of the Remedial Design Guidelines and Considerations (RDGC) related to the comments are cited for reference, as applicable.

No.	Topic	Summary of EPA Comments	Document Type	Related RDGC Section
1.0 Field Documentation				
1.1	Field Deviations	EPA expects field sampling to be conducted according to an approved WP and field sampling plan. Any deviations from these documents must be reported to EPA via field change requests (FCRs) for review and approval prior to implementing the proposed change. The EPA project coordinator or alternate project coordinator will be responsible for coordinating approval of deviations via FCRs.	PDI WP	Not Applicable (NA)
1.2	Field Documentation (Coronavirus Disease 2019 [COVID-19])	EPA's ability to observe site conditions and oversee sampling may be limited by necessary health and safety precautions associated with the current COVID-19 pandemic. EPA requests that additional documentation be collected and provided to enable regulatory personnel to develop a near firsthand understanding of site conditions and field work. EPA is available to discuss the specifics of this request but, conceptually, this could consist of a standard set of photos showing each day's sampling activities provided with a daily report of work activities (all conveyed in an email to EPA and its oversight contractor the following morning).	PDI WP	NA
2.0 Analytical Requirements and Considerations				
2.1	Contaminants of Concern	Evaluation of all Record of Decision (ROD) Table 21 contaminants in PDI sediment samples is expected as part of remedial design and should not be limited to the focused contaminants of concern (COCs). Existing sediment data should be discussed for all ROD Table 21 contaminants and compared to the applicable remedial action levels (RALs) and/or principal threat waste (PTW) thresholds. Riverbank soil samples must be analyzed for contaminants with ROD Table 17 riverbank soil/sediment cleanup levels (CULs) as modified by the 2019 Explanation of Significant Differences and the 2020 Errata #2 memorandum) and Table 21 contaminants per EPA's RDGC Appendix D Section 2.2. Specific contaminants may be excluded from chemical analyses if a technical rationale based on a robust conceptual site model can be provided.	PDI WP and SAR	Appendix B Topic 11, and Appendix D
2.2	Polychlorinated Biphenyl (PCB) Analysis	PCB congener analysis (EPA Method 1668) is preferred for surface and subsurface sediment samples but PCB Aroclor analysis (EPA Method 8082A) is acceptable if the reporting limit for each Aroclor is less than 9 micrograms per kilogram (µg/kg) (the PHSS ROD riverbank soil/sediment CUL). EPA requires archiving and confirmation analyses of archived samples if the results for PCBs by Method 8082A cannot achieve the 9 µg/kg reporting limit. Confirmation analyses will use a high-resolution methodology for congeners (EPA Method 1668). EPA also recommends congener analysis for porewater samples because cap modeling is usually conducted using chemical properties for a specific PCB congener and using modeling parameters for	PDI WP	Appendix B Topic 1

		congeners with total PCB concentrations determined using Aroclor analysis will not provide the most accurate results.		
3.0 Performance Standards and Points of Compliance				
3.1	Screening of Recontamination Potential Chemicals (RPCs)	Proposing a reduced list of RPCs does not eliminate the requirement that all ROD Tables 17 and 21 contaminants be considered in remedial design. The COC screening process/approach only applies to identification of RPCs for evaluating recontamination and not identification of potential driver COCs for remedial design. All contaminants from Table 17 (e.g., for capping effectiveness or dredging leave surface) and Table 21 of the ROD must be considered during remedial design and future performance monitoring.	SAR	Appendix B Topic 11
3.2	Applicable or Relevant and Appropriate Requirements (ARARs)	The ROD identified the ARARs for the selected remedy and those ARARs should not be reinterpreted. All ARARs are pertinent across the entire Site unless specific information shows one or more identified ARARs are not applicable or are not relevant and appropriate to a project area SMA remedial design and remedial action, as approved by EPA.	PDI WP	NA
4.0 Sampling Issues				
4.1	Sampling Interval	The appropriate sampling interval for sediment coring in dredging areas is 1 foot. For areas where the expected remedial technology is capping, the minimum 1-foot sampling interval will not be required; however, the sample interval must be representative of the material being capped. Similar sampling intervals should be considered for riverbank soil borings to avoid inconsistencies between in-water and riverbank remedial design.	PDI WP	Appendix B Topic 5
4.2	Surface Sediment Sampling Depth	The upper 12-inch (30-centimeter) depth is the appropriate surface sediment sampling depth based on the physical and biological characteristics of the Site, is consistent with the surface sediment depths sampled during the remedial investigation and is documented in ROD Section 6.5.2. A depth of 30 centimeters should be used for evaluating long-term predicted average sediment concentrations. Additionally, the long-term predicted average sediment concentrations should be less than the cleanup levels identified in Table 17 of the ROD within the top 30 centimeters.	PDI WP	5.1.2
4.3	SMA Delineation	SMAs are defined by the horizontal and vertical extent of contamination exceeding RALs and/or PTW thresholds and must be delineated during remedial design using surface and subsurface sediment data. The sampling approach for SMA refinement should meet the nominal 150-foot by 150-foot grid spacing identified in Section 5.1.2 of the RDGC. SMA refinement must consider both surface and subsurface sediment exceedances of RALs and PTW thresholds (see Remedial Design Principle #1 in Section 1.4 of EPA's RDGC). EPA recommends that surface grab sampling (3-point composites) be conducted to delineate the SMA, in conjunction with and in addition to subsurface investigation. Delineation of the depth of contamination (DOC) is required for areas with nonaqueous-phase liquid (NAPL) or PTW that cannot be reliably contained, or areas where dredging is the assigned technology. If only subsurface contamination exceeds RALs and/or PTW thresholds and the expected remedial technology application is capping, full delineation of DOC is not necessary. However, characterization of subsurface sediment contamination will be required to sufficiently characterize material to be left in place to support cap design evaluations or to demonstrate the stability of the buried contamination. If DOC is not fully delineated in areas with NAPL or PTW that cannot be reliably contained, or for areas where dredging is the assigned technology, EPA will require additional sampling to delineate DOC.	PDI WP	1.4, 5.1.2, Appendix B Topic 4
4.4	UltraSeep Measurements	Surface waves and wakes due to nearby vessels can influence the results of the UltraSeep system. Appropriate precautions should be taken to address this concern or, at the very least, thorough notes and automatic identification system (AIS) ship logs (large commercial vessels all have AIS transmitters that can be tracked online) should be recorded of possibly interfering vessel	PDI WP	NA

		wakes encountered during seepage meter deployment. Data should also be reviewed for anomalous results, as with any data set.		
5.0 Evaluations and Assessments				
5.1	Cap Design Data Needs	Sediment-based performance standards for caps must be included. Caps must be designed to achieve ROD Table 17 groundwater CULs in porewater and riverbank soil/sediment CULs in surface sediment throughout the upper 12 inches (30 centimeters) of the cap material or deposited sediment. Cap modeling will require site-specific porewater concentrations, groundwater seepage rates, and organic carbon measurements to effectively demonstrate that the contamination will remain reliably contained.	PDI WP	Appendix B Topic 2, Appendix C
5.2	Buried Contamination	By itself, the net depositional nature of a site is not confirmation that natural recovery is occurring through burial of contamination by cleaner sediments. Multiple lines of evidence (e.g., rates of sedimentation, chemical concentration trends, level of statistical certainty surrounding trends) must be evaluated in the BODR to verify that natural recovery is occurring. Physical and chemical stability of buried contamination must be quantitatively verified through fate and transport modeling and other evaluations (see Remedial Design Principle #2), and statements that cannot be supported with existing data are to be avoided in remedial design documents.	PDI WP	1.4, Appendix B Topic 4
5.3	Recontamination Assessment after Remedial Action	Recontamination is assessed after remediation to determine if ROD Table 17 CULs are exceeded in the relevant media over an appropriate time and spatial scale in consideration of achieving the remedial action objectives (RAOs). EPA will evaluate recontamination as part of the five-year review process under the Comprehensive Environmental Response, Compensation, and Liability Act. Design deliverables should be clear that recontamination will be assessed during the five-year reviews and that all Table 17 CULs will be evaluated.	SAR	Appendix C
5.4	Groundwater Pathway Evaluation	Each potential groundwater pathway, including discharge through sediments, discharge through bank seeps, infiltration into storm drains/pipes, and discharge to ditches or creeks that discharge to the Willamette River should be considered and evaluated for each upland property. Sufficient sample location and analytical data must be included to substantiate any conclusions. A discussion of potential unknown groundwater plumes from historical or existing sources should be included to determine whether existing site investigations have adequately and completely characterized groundwater. The source control status for groundwater plumes that may affect achieving any of the RAOs (including those for groundwater/porewater) should be summarized by comparing available data to ROD Table 17 CULs. The fate and transport of COCs at concentrations exceeding CULs in upland groundwater that discharges into Willamette River sediments should be assessed. The sufficiency assessment for each upland groundwater source area should include an evaluation of each pathway and identify the specific source control measures addressing each complete pathway, with monitoring data to support the conclusions. Sources, COCs, and/or and pathways contributing to contamination in the groundwater plumes that have not been effectively addressed and could impact the implementation of the remedial action should be discussed. Potential data gaps associated with groundwater plumes that are considerations for the PDI, or that will be addressed by future evaluations and/or sampling, should be identified.	SAR	NA
5.5	Riverbank Characterization	EPA's expectation is that chemical characterization of riverbanks identified as contaminated in the ROD or adjacent to SMAs and pending characterization needs to be conducted to identify the extent of contamination relative to ROD Table 17 Riverbank Soil/Sediment CULs, Table 21 RALs and PTW thresholds, and any applicable upland screening level values. For riverbanks identified in ROD Section 6.6.6, chemical characterization of riverbanks must extend from the top of the riverbank to the mean low water elevation to determine if the protectiveness goals of the Site RAOs are met. For riverbanks adjacent to SMAs that are pending characterization, chemical	PDI WP and SAR	Appendix D

		characterization starts from the SMA and steps out into the riverbank. The extent of step outs to the top of and laterally on the riverbank depends on the level and type of contamination found. The evaluation and chemical analyses should not be limited only to erodible soils. Expected steps for delineating contamination within a riverbank include: ▪ Characterize the horizontal extent of contaminant concentrations exceeding the criteria listed in ROD Tables 17 and 21 over the riverbank. Compare concentrations in the surficial soil of the riverbank (top 30 centimeters) to CULs, RALs, and PTW threshold values. This includes the presence of NAPL in soil borings or wells at the top of the bank. ▪ If surface sample results exceed PTW threshold values, subsurface sampling to vertically bound the contamination exceeding PTW threshold values must be done. ▪ Delineate NAPL through visual identification, field test methods, in situ methods, ultraviolet optical screening methods, laboratory analysis of soil samples, well installation with appropriately screened intervals, or a combination of these methods. If characterization shows exceedances of ROD Table 17 CULs and/or Table 21 RALs, an erodibility evaluation must be conducted to evaluate the riverbank erosion pathway for chemical transport to the river. If characterization shows exceedances of Table 21 PTW thresholds, design requirements found in ROD Section 14.2.9 will be followed. If riverbank characterization was addressed through a previous removal action or through the source control process, relevant information and discussion should be included in the remedial design deliverable. In some situations, if characterization has already been completed, sampling for all Table 17 contaminants on a riverbank may not be required. See **Appendix D** for additional details on riverbank characterization requirements.		
5.6	Seepage Rates for Cap Design	It should be recognized that there will be a large degree of extrapolation and uncertainty associated with the seepage meter data that in-turn will present a range of flux estimates throughout the site. EPA expects that a range of measured seepage rates will be evaluated in cap design modeling to address uncertainty and to develop a better understanding of chemical fate and transport under varying conditions (see Appendix B, Topic 2). Final cap design parameters will be selected in consultation with EPA at a later stage of the remedial design process.	PDI WP	Appendix B Topic 2
5.7	Benthic Toxicity Testing	Benthic toxicity testing to be performed during remedial design should include the 10-day survival and biomass test using the midge *Chironomus dilutus* (acute) and the 28-day survival and biomass test using the amphipod *Hyalella azteca* (chronic), consistent with the Portland Harbor baseline ecological risk assessment (BERA). The benthic toxicity testing result interpretation will be based on the acceptance criteria (hit definitions) outlined in the Northwest Regional Sediment Evaluation Team's *Sediment Evaluation Framework for the Pacific Northwest* (SEF), consistent with ROD responsiveness summary Section 2.34.1. In addition to the acceptance criteria in the SEF, EPA recommends that toxicity responses be interpreted using the reference envelope approach as was performed in the BERA. Project area-specific decisions regarding benthic toxicity testing requirements may be considered in consultation with EPA.	PDI WP	NA
6.0 Data Issues				
6.1	Data Replacement	A comprehensive data replacement approach for surface sediment data should be provided for EPA review and approval. The age of the data is not the only consideration for data replacement, and the presence of outliers, heterogeneity of the substrate, natural recovery occurrence, deposition, erosion/scour potential, and sampling density/resolution also need to be considered consistent with the data replacement discussion (Remedial Design Principle #3) in Section 1.4 of EPA's RDGC. Any proposed data replacement approach should enhance investigation data quality objectives and the effort	PDI WP	1.4, Appendix B Topic 10

		to accurately resolve the spatial bounds of contamination. Data replacement should only occur after collection of PDI data such that the newer PDI and the 2018–2019 PDI/baseline data inform the replacement of the older remedial investigation/feasibility study (RI/FS) data. The older RI/FS data should only be replaced when concentrations have changed substantively over time, subject to the considerations noted above and described in EPA's RDGC, and when spatial resolution is at least maintained or improved. See Appendix B, Topic 10 for additional details.		
6.2	EPA-Approved Data	All data used in remedial design deliverables should come from EPA-approved datasets posted to the Portland Harbor Environmental Data Portal and not from databases compiled in other sources or reports. EPA-approved datasets can be found in the Portland Harbor Environmental Data Portal at the following link: http://ph-public-data.com/.	SAR and PDI WP	NA
7.0 Long Term Monitoring and Maintenance				
7.1	Operational Considerations	Operational considerations will include planned monitoring and maintenance of features such as caps, and descriptions should include the type of monitoring to be expected for each medium (e.g., sediment, porewater, surface water). The project area monitoring plan (or equivalent) should also note that caps will include both physical and chemical monitoring. Other cap monitoring considerations, such as sampling access points through armor stone and confirmation cores to determine as-built cap thickness and active amendment composition, should also be noted as being considered during remedial design.	PDI WP	Appendix C
7.2	Long-Term Monitoring	Long-term monitoring will be the responsibility of the performing party and any groups of parties that undertake long-term remedial goal monitoring on a Sitewide basis. At a minimum, the performing party group's responsibilities will include monitoring the performance of any remedy they construct to determine that it is functioning as intended. In the project area monitoring plan (or equivalent), data needs for the following should be considered: ▪ Baseline characterization necessary to support the requirements of long-term monitoring and maintenance ▪ The five-year review stipulated in Section 14.2.8 of the ROD ▪ Monitoring of natural recovery ▪ Organic carbon content of the incoming material, consistent with the background determination, needed to evaluate long-term effectiveness relative to upstream conditions	PDI WP and BODR	Appendix C
8.0 Other				
8.1	Sufficiency Status Documentation	For "C" status sites, the sufficiency assessment matrix should differentiate between sites that have uncontrolled sources and sites where additional assessment is recommended, using a C(u) for uncontrolled sources and a C(a) for sites where additional assessment is recommended.	SAR	NA
8.2	Remedy Sequencing	The remedial action is to be sequenced appropriately with upland source control actions and remedial action at other sites. Future remedial design deliverables will consider appropriate sequencing of remedial actions such that recontamination potential from upstream sources is minimized during remedy construction.	PDI WP and SAR	NA
8.3	Seismic Considerations	Remedial design documents should consider how seismic events might impact recontamination from both an upland and in-water standpoint. An assessment of these additional factors should be included.	SAR	5.2.5