

100% Remedial Design Basis of Design Report

Appendix F

Design Considerations for cPAH RAL

Exceedance Areas Relative to

2014 ROD RALs

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ABBREVIATIONS

BODR	<i>Basis of Design Report</i>
cm	centimeter
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DER	<i>Pre-Design Investigation Data Evaluation Report for the Lower Duwamish Waterway Upper Reach</i>
DQO	data quality objective
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
ESD	<i>Explanation of Significant Differences</i>
FNC	federal navigation channel
LDW	Lower Duwamish Waterway
MLLW	mean lower low water
PCB	polychlorinated biphenyl
PDI	pre-design investigation
QAPP	Quality Assurance Project Plan
RAA	remedial action area
RAL	remedial action level
RD	remedial design
RM	river mile
ROD	<i>Record of Decision</i>
SMA	sediment management area
TEQ	toxic equivalent

1 Introduction

As described in the *Pre-Design Investigation Data Evaluation Report for the Lower Duwamish Waterway Upper Reach* (DER) (LDW; Anchor QEA and Windward 2022a), remedial action level (RAL) exceedance areas were developed by comparing data in the design dataset with RALs, as defined in the U.S. Environmental Protection Agency's (EPA's) November 2014 Lower Duwamish Waterway (LDW) *Record of Decision* (ROD; EPA 2014) for all contaminants of concern (COCs) except carcinogenic polycyclic aromatic hydrocarbons (cPAHs). RAL exceedance areas for cPAHs presented in the DER were based on RALs presented in the LDW *Explanation of Significant Differences* (ESD); EPA 2021). EPA prepared the ESD for cPAHs to re-calculate the cPAH RALs, cleanup levels, and target tissue levels to reflect the latest scientific understanding of cPAH toxicity. The ESD provides the RALs that require remedial action in the LDW for cPAHs, which have higher concentrations than those presented in the ROD.

Appendix B of the DER evaluated whether additional areas with RAL exceedances would be identified if the areas were based on the 2014 ROD RALs for cPAHs. Appendix B of the DER identified two areas where this would be the case.

The Lower Duwamish Waterway Group is voluntarily preparing a design that addresses additional RAL exceedance areas identified using the 2014 ROD RALs for cPAHs (pre-ESD). The purpose of this appendix is to describe the basis of design for these areas. In general, the remedy elements discussed in the Final (100%) Remedial Design (RD) *Basis of Design Report* (BODR) are applicable to these areas, so this appendix focuses on considerations specific to each area.

This appendix presents the following:

- An overview of the two areas that exceed the 2014 ROD RALs (referred to as cPAH-only areas)
- Comparison of Phase III pre-design investigation (PDI) data with 2014 ROD RALs
- Technology assignment for the cPAH-only areas identified using 2014 ROD RALs
- A discussion of the cPAH-only remedial action area (RAA) boundary and sediment management area (SMA) boundary development
- Design drawing, quantities, and opinion of probable cost of the additional cPAH-only remediation

2 Technology Assignments for Areas with 2014 ROD RAL Exceedances for cPAHs

Appendix B of the DER (Anchor QEA and Windward 2022a) identified two areas that exceed the 2014 ROD RALs for cPAHs but do not exceed the ESD RALs and are not already included within a RAL exceedance area delineated by other COCs at those locations. Both areas are based on surface sediment exceedances; one includes a small area immediately adjacent to RAA 18 (river mile [RM] 3.8 East), and the other is an area west of the Turning Basin (RM 4.7 West).

As discussed in the Final (100%) RD BODR, the remedy at RAA 18 is being deferred due to Washington State Department of Ecology source control sufficiency findings. This cPAH-only area is also within this deferred area and will be addressed as part of a later stage of the overall Superfund Site cleanup.

The technology assignments for the remaining cPAH-only area west of the Turning Basin (RM 4.7 West) is enhanced natural recovery (ENR). This technology was selected because there are no structural limitations, the area is Recovery Category 3, and the cPAH concentrations are less than the ENR upper limit (ROD Table 28; EPA 2014).

3 Updated Design Dataset for the Upper Reach

This section presents an updated comparison of cPAH toxic equivalents (TEQs) with the 2014 ROD RAL for cPAHs—this comparison was previously presented in Appendix B of the DER (Anchor QEA and Windward 2022a) after the Phase II data collection effort. The comparison presented here uses the updated design dataset for the upper reach, which includes the Phase III data collected in December 2022.

As described in Appendix C of the Phase III Quality Assurance Project Plan (QAPP) Addendum (Anchor QEA and Windward 2022b), data gaps were evaluated for the two cPAH-only areas based on meeting PDI data quality objectives (DQOs; Table F3-1). No data gaps were identified for the area adjacent to RAA 18 (RM 3.8 East). For the area west of the Turning Basin (RM 4.7 West), additional bounding of the horizontal extent of the exceedance at SS384 was identified to refine the footprint in this area, if possible, so as to avoid disturbing habitat.

**Table F3-1
Evaluation of Data Gaps for cPAH 2014 ROD RAL Areas**

DQO	Phase III PDI Data Gaps
Further horizontal delineation (DQOs 9 and 10)	Surface samples to bound the horizontal footprint and avoid disturbing habitat in the Turning Basin
Further vertical delineation (DQO 12)	None
Other engineering data (DQO 14)	None

Notes:
cPAH: carcinogenic polycyclic aromatic hydrocarbon
DQO: data quality objective
PDI: pre-design investigation
RAL: remedial action level
ROD: *Record of Decision*

To refine the bounding of the area west of the Turning Basin, as described in Appendix C of the Phase III QAPP Addendum (Anchor QEA and Windward 2022b), two surface (0- to 10-centimeter [cm]) sediment samples were collected between SS384 and the shoreline during the December 2022 Phase III PDI sampling (Map F-1). SS384 had a cPAH TEQ of 1,980 µg/kg dry weight (0 to 10 cm).

cPAH TEQs for the two Phase III samples were below the 2014 ROD RAL of 1,000 micrograms per kilogram (µg/kg) dry weight (Table F3-2). Thus, there were no new exceedances of the 2014 ROD RAL for cPAH in the design dataset (Table F3-3), and the boundary was refined by the Phase III samples at locations 824 and 825. Map F-1 depicts the refined boundary of the cPAH-only area at this location.

Table F3-2
Additional Phase III samples analyzed for cPAHs

Area	Phase III Sample				Rationale for Analysis
	Location Number	Sample ID	Interval (cm)	cPAH TEQ (µg/kg dry weight)	
Turning Basin; RM 4.6 East	824	SS824	0–10	66.7	Bounding horizontal extent in surface sediment between SS384 and shoreline
	825	SS825	0–10	59.7	

Notes:
cPAH: carcinogenic polycyclic aromatic hydrocarbon
ID: identification
RM: river mile
TEQ: toxic equivalent

Table F3-3
Summary of cPAH RAL Exceedances in the Design Dataset

Interval	Comparison with 2014 cPAH ROD RALs		Comparison with cPAH ESD RALs	
	No. > RAL/Total	%	No. > RAL/Total	%
Surface (0–10 cm)	9/510	2	1/510	0.2
Subsurface (0–45 cm)	1/61	2	0/61	0
Subsurface (0–60 cm)	0/36	0	0/36	0
Shoal intervals (depth varies) ¹	1/30	3	0/30	0

Notes:
1. Shoal interval samples consisted of shoaled material in the FNC (i.e., sediment above -15 feet MLLW in this reach of the LDW) and sediment from the -15- to -17-foot overdredge interval.
cPAH: carcinogenic polycyclic aromatic hydrocarbon
ESD: explanation of significant differences
FNC: Federal Navigation Channel
LDW: Lower Duwamish Waterway
MLLW: mean lower low water
RAL: remedial action level
ROD: Record of Decision

Based on the Phase III results, Map F-2 shows the updated cPAH-only RAL exceedances areas (i.e., where RAL exceedances areas would change with the use of the 2014 ROD RAL for cPAHs). Specifically, the map incorporates Thiessen polygons for cPAH-only exceedances of the 2014 ROD RAL; the additional areas are shown as orange polygons. There are no changes to the area adjacent to RAA 18. For the area to the west of the Turning Basin, the new Phase III cPAH data decrease the size of the Thiessen polygon related to the 2014 cPAH ROD RAL exceedance.

4 Remedial Action Area and Sediment Management Area Development

This section discusses development of the RAA and SMA for the cPAH-only area. Sheet C161 of the Final (100%) Drawings (Volume III) shows the SMA for this area.

4.1 Remedial Action Area Development

The horizontal extents of contamination for non-polychlorinated biphenyl (PCB) exceedances are defined using Thiessen polygons, as described in BODR Section 4 and Appendix K of the DER. Therefore, the starting point to define the RAA for the cPAH-only areas (based on 2014 ROD RALs) is the RAL exceedance area. The RAA development process is described in detail in BODR Section 6. Following this process for the cPAH-only area in the Turning Basin, a 10-foot placement buffer was added to the 2014 cPAH ROD RAL exceedance area, consistent with other locations where ENR is the selected remedy. ENR placement will be carefully controlled and monitored during construction to prevent disturbance of the adjacent habitat.

4.2 Sediment Management Area Development

The SMA development process is described in detail in BODR Section 7. For the cPAH-only area in the Turning Basin, an independent SMA has been defined based on its distance from other RAAs, technology assignment, and site access considerations. The SMA is numbered separately from the remaining site and is called "SMA-c1."

5 SMA-c1 Quantity and Engineer’s Cost Estimate Summary

This section presents the quantities and costs associated with SMA-c1.

As noted, ENR is the selected remedial technology for this area. This SMA (including the 10-foot buffer around the planned ENR placement area) is 2,240 square feet. Assuming ENR material (medium-to-coarse grained sand) is applied over the ENR placement area at a 9-inch targeted placement thickness (including a 3-inch vertical placement tolerance), the total ENR placement volume is 83 cubic yards.

The Final (100%) RD Engineer’s Cost Estimate to implement the remediation of this cPAH-only area is summarized in Table F5-1. This work would likely be integrated with other remedial actions described in the Final (100%) RD BODR; therefore, some efficiencies and cost savings would be realized. The total project cost includes costs for direct construction tasks (i.e., all construction activities anticipated to be conducted by the contractor), indirect construction tasks (i.e., additional activities to provide quality assurance that are necessary to the project but are performed by parties other than the contractor), and additional construction oversight tasks (by EPA). The total Final (100%) RD probable (most likely) cost for LDW upper reach implementation at the Final (100%) RD is \$207,200.

**Table F5-1
Engineer’s Cost Estimate for Implementation of SMA-c1**

Task ID	Task Description	Probable Total Cost (\$)
Direct Construction Costs		
1	Mobilization/Demobilization	\$61,500.00
2	Surveys	\$19,000.00
3	Material Placement	\$29,420.00
Direct Construction Costs Subtotal		\$109,920.00
4	Direct Construction Contingency (25.0%)	\$27,480.00
Direct Construction Costs Subtotal with Contingency		\$137,400.00
5	Sales Tax (10.1%)	\$13,880.00
Total Direct Construction Costs (with Contingency and Sales Tax) (rounded)		\$151,300.00
Indirect Construction Costs		
6	Project Management	\$11,100.00
7	Construction Quality Assurance	\$15,000.00
Indirect Construction Costs Subtotal		\$26,100.00
8	Indirect Construction Contingency (25.0%)	\$6,530.00

Task ID	Task Description	Probable Total Cost (\$)
Total Indirect Construction Costs (with Contingency) (rounded)		\$32,600.00
Additional Construction Oversight Costs		
9	Additional Construction Oversight Costs	\$18,600.00
Additional Construction Oversight Costs Subtotal		\$18,600.00
10	Additional Construction Oversight Contingency (25.0%)	\$4,650.00
Total Additional Construction Oversight Costs (with Contingency) (rounded)		\$23,300.00
11	Total SMA-c1 Project Costs (rounded)	\$207,200.00

Notes:

- Costs are presented in present-day (i.e., 2023) U.S. dollars.
- Sales tax is included at 10.1% to account for Washington State (6.5%) and the City of Tukwila (3.6%) taxes.
- A 25% contingency is applied to total direct construction, total indirect construction costs, and additional construction oversight costs, based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgment. Due to the nature of the construction activity (i.e., environmental sediment remediation), additional factors that cannot be forecasted at this time—such as scope unknowns (i.e., significant changes in site conditions or quantities), price uncertainty (i.e., varying market conditions, increasing inflation, and fuel and labor changes), or any other unforeseen circumstances (i.e., additional design requirements)—may influence contractor bidding prices and impact the final project costs outside, in excess, or below this contingency.
- Long-term monitoring costs for SMA-c1 are not included in this engineer's cost estimate as assumptions for these activities will be developed consistent with the Long-Term Maintenance and Monitoring Plan.

RD: remedial design

SMA: sediment management area

6 References

Anchor QEA and Windward (Anchor QEA, LLC; Windward Environmental LLC), 2022a. *Pre-Design Investigation Report for the Lower Duwamish Waterway Upper Reach*. Draft. February 21, 2022.

Anchor QEA and Windward, 2022b. *Quality Assurance Project Plan Addendum for the Lower Duwamish Waterway Upper Reach: Pre-Design Investigation Phase III*. Final. November 17, 2022.

EPA (U.S. Environmental Protection Agency), 2014. *Record of Decision*. Lower Duwamish Waterway Superfund Site. U.S. Environmental Protection Agency Region 10. November 2014.

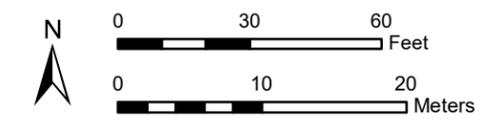
EPA, 2021. *Explanation of Significant Differences*. Lower Duwamish Waterway Superfund Site. September 2021.

Maps



- Surface sediment sampling location with cPAH TEQ greater than the 2014 ROD RAL^a
- Surface sediment sampling location with cPAH TEQ less than the 2014 ROD RAL
- ◇ 0-45 cm core with cPAH TEQ less than the 2014 ROD RAL
- cPAH ROD RAL exceedance area
- RAL exceedance area
- ▨ Recovery Category 1
- ▨ Intertidal area
- ▨ LDW Superfund Boundary
- ▨ King Co tax parcel
- Federal Navigation Channel
- River mile

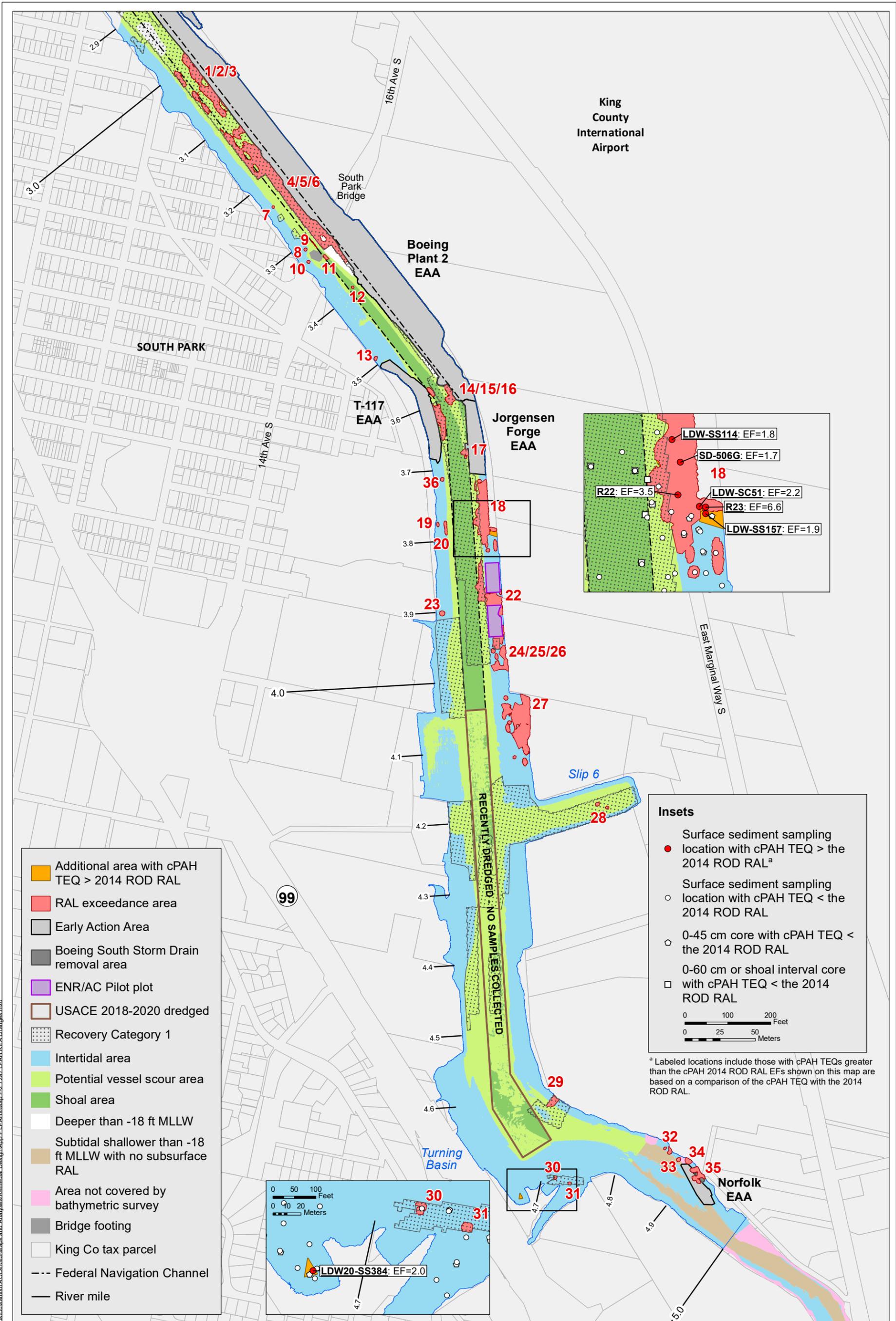
^a Labeled locations include those with cPAH TEQs greater than the cPAH 2014 ROD RAL EFs shown on this map and are based on a comparison of the cPAH TEQ with the 2014 ROD RAL.
 Note: ROD Table 28 is the source of RALs for COCs that were used to calculate exceedance factors, except for cPAHs, which use the cPAH ESD RALs (EPA 2021).



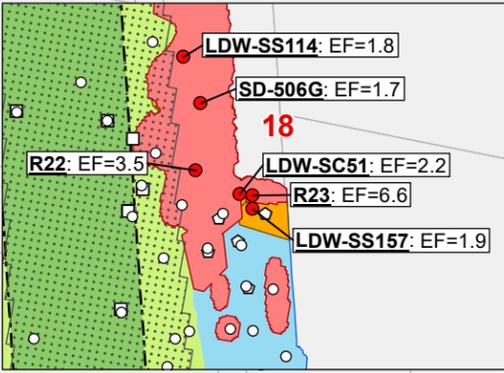
Map F-1. Phase III surface sediment locations to refine cPAH-only ROD RAL exceedance area

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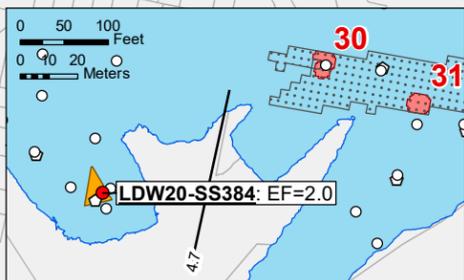
DECEMBER 15, 2023



- Additional area with cPAH TEQ > 2014 ROD RAL
- RAL exceedance area
- Early Action Area
- Boeing South Storm Drain removal area
- ENR/AC Pilot plot
- USACE 2018-2020 dredged
- Recovery Category 1
- Intertidal area
- Potential vessel scour area
- Shoal area
- Deeper than -18 ft MLLW
- Subtidal shallower than -18 ft MLLW with no subsurface RAL
- Area not covered by bathymetric survey
- Bridge footing
- King Co tax parcel
- Federal Navigation Channel
- River mile



- Insets**
- Surface sediment sampling location with cPAH TEQ > the 2014 ROD RAL^a
 - Surface sediment sampling location with cPAH TEQ < the 2014 ROD RAL
 - ◊ 0-45 cm core with cPAH TEQ < the 2014 ROD RAL
 - ◻ 0-60 cm or shoal interval core with cPAH TEQ < the 2014 ROD RAL
- 0 100 200 Feet
0 25 50 Meters
- ^a Labeled locations include those with cPAH TEQs greater than the cPAH 2014 ROD RAL EFs shown on this map are based on a comparison of the cPAH TEQ with the 2014 ROD RAL.



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