

60% Remedial Design Basis of Design Report

Appendix E

Design Considerations for cPAH RAL Exceedance Areas Relative to 2014 ROD RALs

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ABBREVIATIONS

µg/kg	microgram per kilogram
AST	area-specific technology
BODR	<i>Basis of Design Report</i>
cm	centimeter
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DER	<i>Pre-Design Investigation Data Evaluation Report for the Lower Duwamish Waterway – Middle Reach</i>
EF	exceedance factor
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
ESD	<i>Proposed Explanation of Significant Differences</i>
FNC	federal navigation channel
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
NA	not applicable
PCB	polychlorinated biphenyl
PDI	pre-design investigation
RAA	remedial action area
RAL	remedial action level
RD	remedial design
RM	river mile
RMC	residuals management cover
ROD	<i>Record of Decision</i>
TEQ	toxic equivalents
USACE	U.S. Army Corps of Engineers

1 Introduction

As described in the *Pre-Design Investigation Data Evaluation Report for the Lower Duwamish Waterway – Middle Reach* (DER) for the middle reach of the Lower Duwamish Waterway (LDW; Anchor QEA and Windward 2025), 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 LDW *Record of Decision* (ROD; EPA 2014) for all contaminants of concern except carcinogenic polycyclic aromatic hydrocarbons (cPAHs). RAL exceedance areas for cPAHs presented in the DER were based on RALs presented in the LDW *Proposed Explanation of Significant Differences* (ESD; EPA 2021). The ESD for cPAHs was prepared by EPA to recalculate the cPAH RALs, cleanup levels, and target tissue levels to reflect the latest scientific understanding of cPAH toxicity. The ESD establishes the final cPAH RALs that require remedial action in the LDW, which are higher than those presented in the earlier 2014 ROD. RALs for cPAHs are expressed as toxic equivalents (TEQs) (i.e., cPAH TEQs), which relate the toxicities of the seven cPAHs to that of benzo(a)pyrene.¹

Appendix L 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 L of the DER identified eight areas where this would be the case (Figure E1-1; Anchor QEA and Windward 2025).

The Lower Duwamish Waterway Group (LDWG) is voluntarily preparing a design that considers additional cPAH-only RAL exceedance areas identified using the 2014 ROD RALs for cPAHs (pre-ESD) and the potential for human exposure to occur in these areas. The purpose of this appendix is to describe the basis of design for these areas. In general, the remedy elements discussed in the main *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 areas that exceed the 2014 ROD RALs (referred to as cPAH-only areas)
- Technology assignments for the cPAH-only areas identified using 2014 ROD RALs
- Overview of approach for future cPAH-only remedial action area (RAA) boundary development
- Approach for estimating cost for the additional cPAH-only remediation areas
- A discussion of anticipated Phase III pre-design investigation (PDI) data gaps associated with the cPAH-only areas identified using 2014 ROD RALs

¹ The seven cPAHs included in the cPAH TEQ are benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. cPAH TEQs can also be referred to as benzo(a)pyrene equivalents, as in the ESD (EPA 2021).

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

Appendix L of the DER identified eight areas where cPAH TEQ polygons associated with samples that exceed the 2014 ROD RALs for cPAHs extended beyond the RAL exceedance area boundaries in the DER (Anchor QEA and Windward 2025). This section provides an updated description of these areas relative to the RAAs (Figure E1-1) and identifies technology assignments for each area (Table E2-1). Given that this is a voluntary action being conducted by LDWG, technology assignment rules provided in the ROD were used as a guideline.

Table E2-1
cPAH-Only Areas and Preliminary Technology Assignments

Location of cPAH-Only Area	Exceedance Type (ROD RAL EF)	Area Description	Technology Assignment
RM 1.6 in FNC	Subsurface shoaling area (EF of 2.0)	Exceedance in overdredge interval is currently buried beneath shoaled material, meaning there is no potential for exposure. If USACE FNC maintenance dredging is conducted in this area in the future, this material will be removed (based on PDI data, this material would qualify for open-water disposal). Thus, no action is planned.	NA (no remedy)
RM 2.3E	Surface (EF of 1.4)	The sample with cPAHs above the 2014 ROD RAL is in an intertidal area within the RAA 23A/B boundary. A portion of the cPAH polygon extends beyond the RAA 23A/B boundary, some of which includes the riprap slope.	ENR (for the portion not addressed by RAA 23A/B remedy and not within the riprap slope)
RM 2.4E	Surface (EFs of 1.6–2.0) Subsurface (EFs of 1.0–3.7)	The samples with cPAHs above the 2014 ROD RAL are in an intertidal area within the RAA 20A boundary. In addition, nearby subtidal data were reviewed, and it was determined there is a low potential for exposure to cPAHs at concentrations above the ROD RAL in the adjacent subtidal area. cPAHs in the surface (0–10 cm) and subsurface (0–60 cm) intervals were well below the 2014 ROD RAL. As compared with the 2014 ROD RAL of 1,000 µg/kg, cPAH TEQs ranged from 84.5 to 230 µg/kg in surface sediment and from 188 to 381 µg/kg in subsurface sediment. Additional Phase III samples are being collected in this area to refine the RAA 20A boundary and the extent of cPAH concentrations above the 2014 ROD RAL.	NA (anticipated to be addressed by RAA 20A; to be confirmed based on Phase III data)

Location of cPAH-Only Area	Exceedance Type (ROD RAL EF)	Area Description	Technology Assignment
RM 2.6W	Surface (EF of 1.6)	The sample with cPAHs above the 2014 ROD RAL is in an intertidal area.	ENR
RM 2.6E	Surface (EF of 1.1)	The sample with cPAHs above the 2014 ROD RAL is in an intertidal area adjacent to RAA 12. The depth of contamination for RAA 12 is currently unknown, thus the RAA 12 boundary currently reflects a 1.5-foot dredge cut. Changes to the RAA boundary here based on Phase III data collection may result in this sample being addressed by the RAA 12 remedy. Perimeter RMC placement would also address a portion of this area (including the sample location).	ENR (may be addressed by RAA 12 remedy; to be determined based on Phase III data)
RM 2.7W	Surface (EF of 1.9) Subsurface (EFs of 1.0–1.3)	The samples with cPAHs above the 2014 ROD RAL are in intertidal and subtidal areas within the RAL exceedance area 8 boundary. The portion of the cPAH polygon that extends beyond the RAA boundary will be addressed by expanding ENR placement for RAA 8H and by perimeter RMC for 8E.	ENR (expand footprint of RAA 8H remedy)
RM 2.7E	Surface (EF of 1.6)	The samples with cPAHs above the 2014 ROD RAL are in the intertidal area within the RAL exceedance area 9 boundary. The remnant area of the cPAH polygon that extends beyond the boundary of RAA 9M is within the offset from the historic structure. Thus, no additional action is planned.	NA (addressed by RAA 9M remedy and remnant within structure offset)
RM 2.9W	Subsurface (EF of 2.8)	The sample with cPAHs above the 2014 ROD RAL is in an intertidal area adjacent to an overwater structure.	ENR/AST

Notes:

Green shading indicates the areas that have been identified as potential cPAH RAAs.

µg/kg: microgram per kilogram

AST: area-specific technology

cm: centimeter

cPAH: carcinogenic polycyclic aromatic hydrocarbon

EF: exceedance factor

ENR: enhanced natural recovery

FNC: federal navigation channel

NA: not applicable

PDI: pre-design investigation

RAA: remedial action area

RAL: remedial action level

RM: river mile

RMC: residuals management cover

ROD: *Record of Decision*

TEQ: toxic equivalents quotient

USACE: U.S. Army Corps of Engineers

3 Remedial Action Area Development

The horizontal extents of contamination for non-polychlorinated biphenyl (PCB) exceedances are defined using the Thiessen polygon method, as described in Section 4 of the BODR and Appendix L of the DER (Anchor QEA and Windward 2025). Therefore, the starting point to define RAAs for the cPAH-only areas (based on 2014 ROD RALs) is simply the RAL exceedance area. The RAA development process is described in detail in Section 5 of the BODR. Specific RAAs for the cPAH-only areas will be developed as part of Pre-Final (90%) remedial design (RD) following receipt of Phase III PDI data, which help refine the extent of the areas.

4 cPAH-Only Area Quantity and Opinion of Probable Cost Summary

This section describes the approach for developing the quantities and costs associated with the cPAH-only RAAs. As noted previously, enhanced natural recovery (ENR) is anticipated to be used to address the cPAH-only RAAs. The combined area of the RAAs (including the 10-foot buffer around the planned ENR placement areas) and total ENR placement volume will be determined as part of Pre-Final (90%) RD once more certainty regarding these cPAH-only areas is available. Costs for these cPAH-only areas will be presented as part of Pre-Final (90%) RD and will be developed separately from costs for all other RAAs.

5 References

- Anchor QEA and Windward (Windward Environmental LLC), 2025. *Pre-Design Investigation Data Evaluation Report for the Lower Duwamish Waterway – Middle Reach*. Lower Duwamish Waterway Middle Reach. Final. Submitted to U.S. Environmental Protection Agency. September 30, 2025.
- EPA (U.S. Environmental Protection Agency), 2014. *Record of Decision*. Lower Duwamish Waterway Superfund Site. United States Environmental Protection Agency Region 10. November 2014.
- EPA, 2021. *Proposed Explanation of Significant Differences*. Draft for public comment. Lower Duwamish Waterway Superfund Site. U.S. Environmental Protection Agency Region 10, Seattle, Washington.

Figure
